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Watson

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(54) **SYSTEM FOR HOLDING A LINEAR MOTION GUIDE TRACK TO A SUPPORT BASE AND METHOD THEREFOR**

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(73) Assignee: **Bishop-Wisecarver Corporation**, Pittsburg, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 460 days.

(21) Appl. No.: **12/939,804**

(22) Filed: **Nov. 4, 2010**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation-in-part of application No. 12/643,785, filed on Dec. 21, 2009, now Pat. No. 8,434,946, which is a continuation-in-part of application No. 12/260,754, filed on Oct. 29, 2008, now Pat. No. 8,491,193.

(51) **Int. Cl.**
F16C 19/00 (2006.01)

(52) **U.S. Cl.**
USPC **384/55**; 384/58

(58) **Field of Classification Search**
USPC 384/50, 53–55, 57–59; 403/373, 374.1, 403/381; 248/307, 313
See application file for complete search history.

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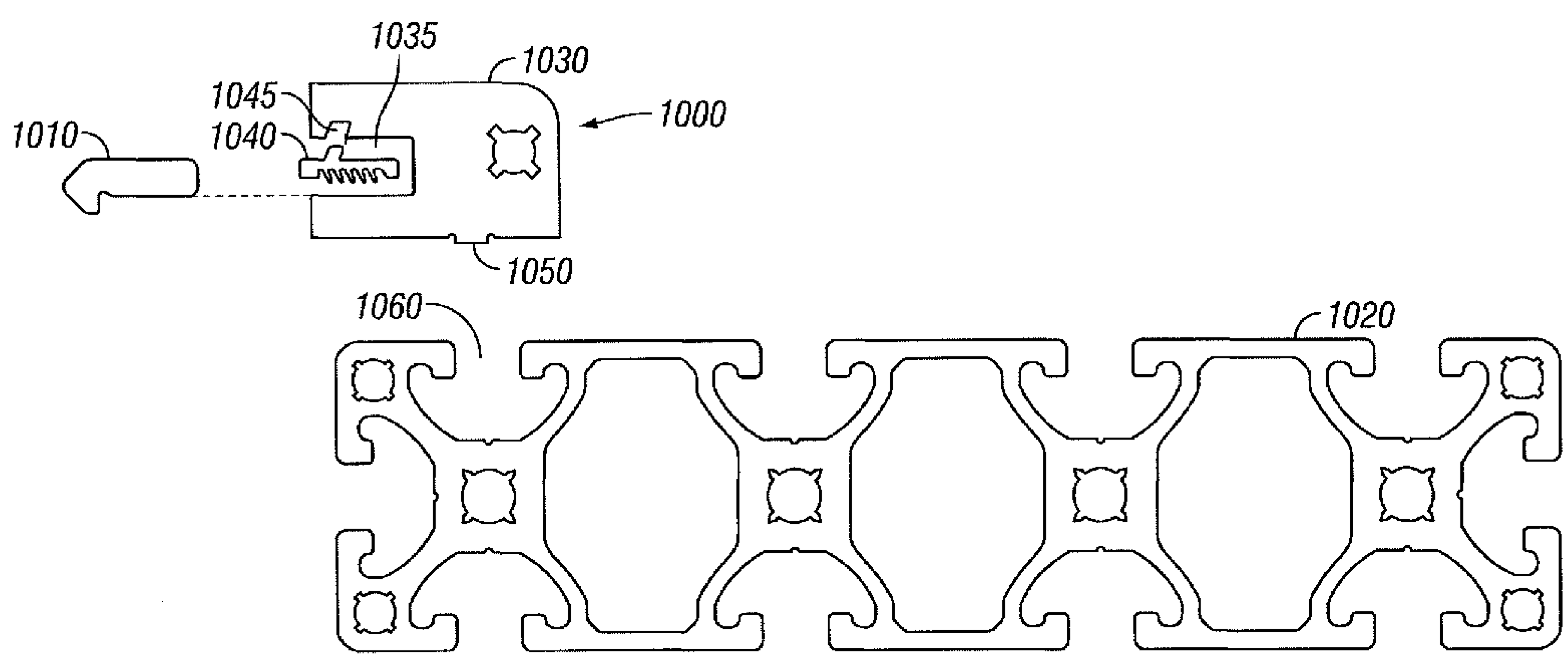
Primary Examiner — James Pilkington

(74) *Attorney, Agent, or Firm* — Brian Beverly; Beeson Skinner Beverly, LLP

(57) **ABSTRACT**

A system for securing a linear motion guide track (**1010**) to a support extrusion (**1030**) comprises an elongated wedge (**1040**) having a protrusion configured for insertion in a slit in one side of the well of the support extrusion for positioning the wedge in the well, the wedge having deformable teeth on a side opposite the protrusion such that insertion of the guide track in the well deforms the teeth of the wedge thereby securely holding the guide track in the support extrusion.

19 Claims, 22 Drawing Sheets



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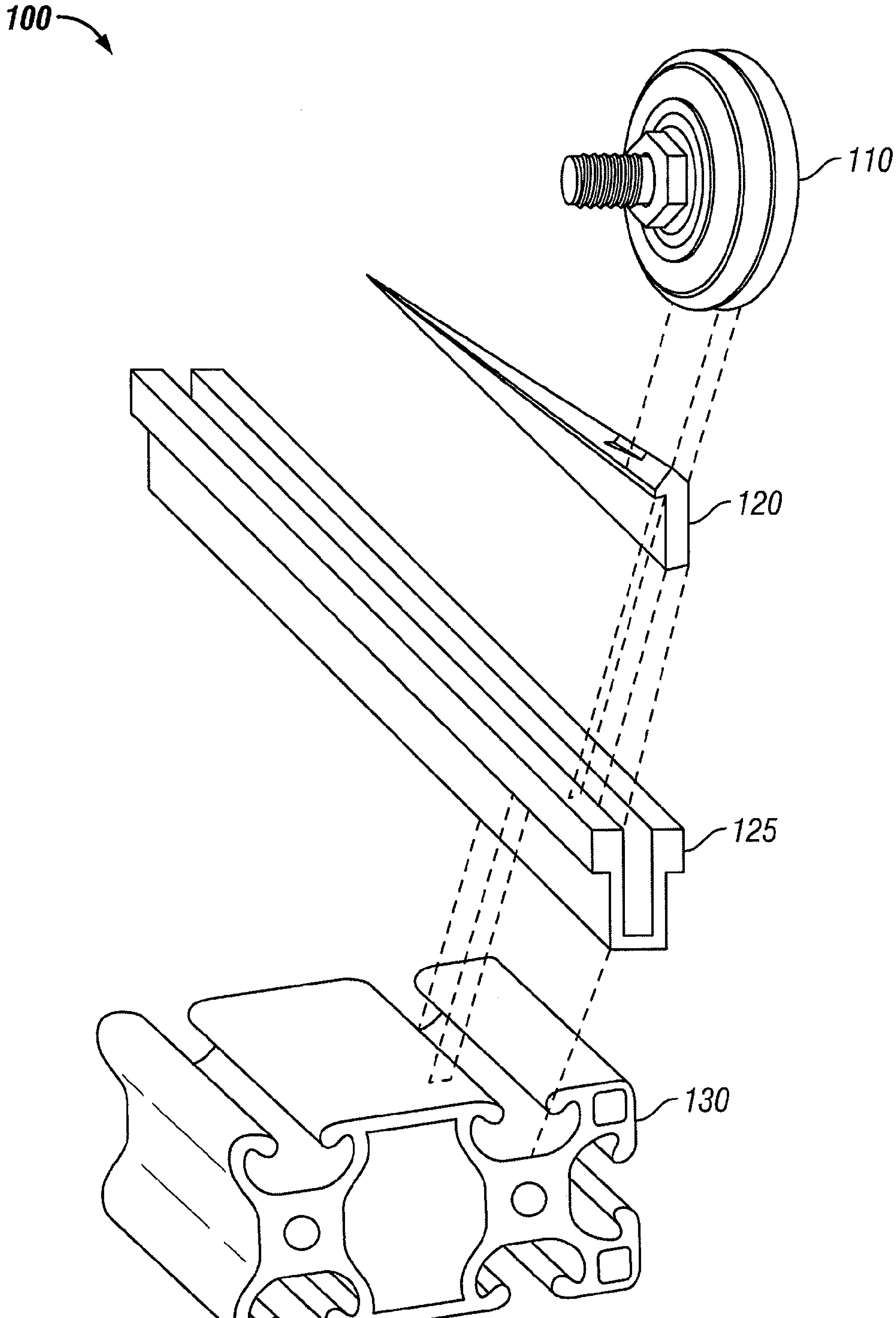

FIG. 1
(Prior Art)

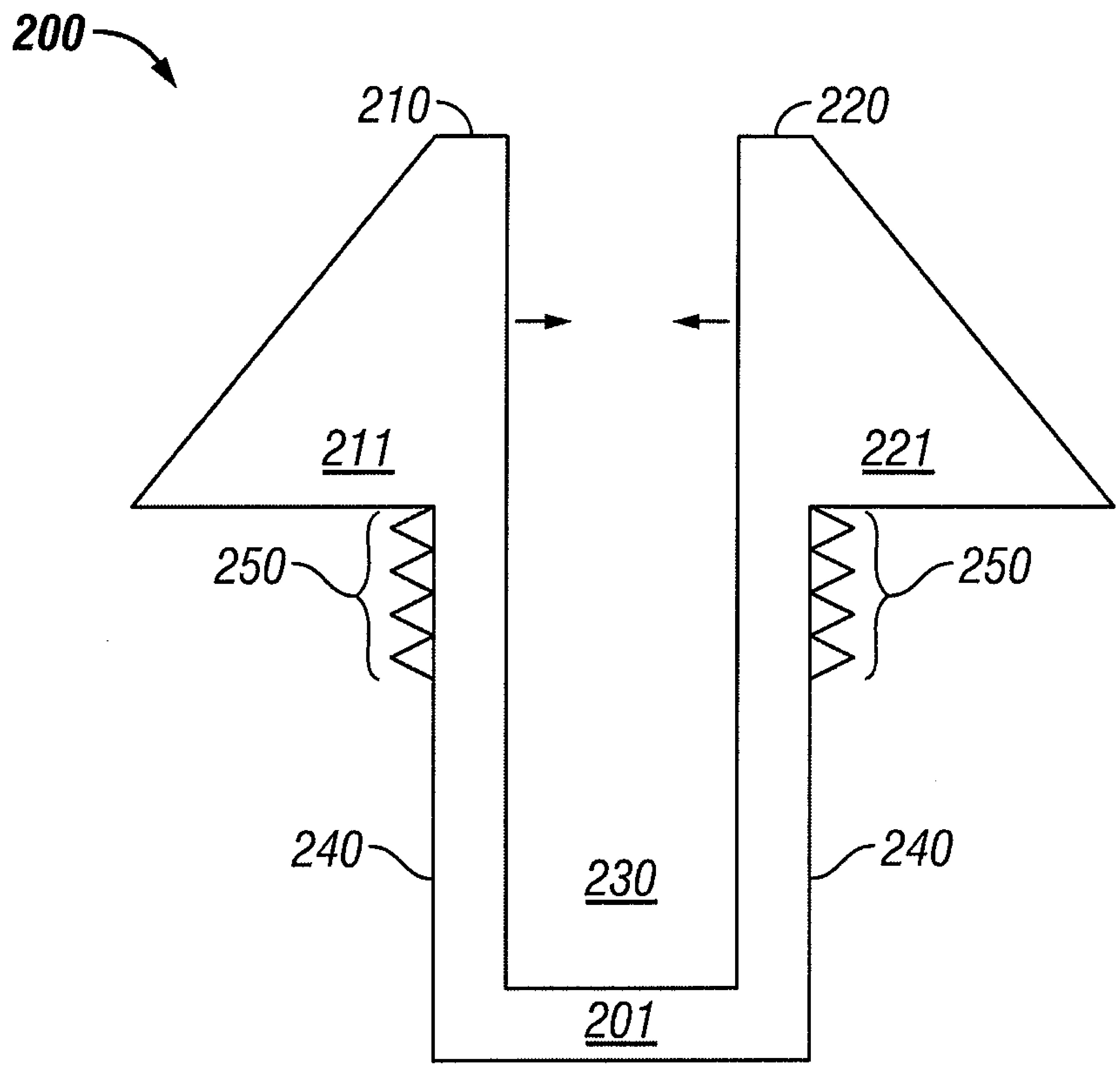
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FIG. 2A

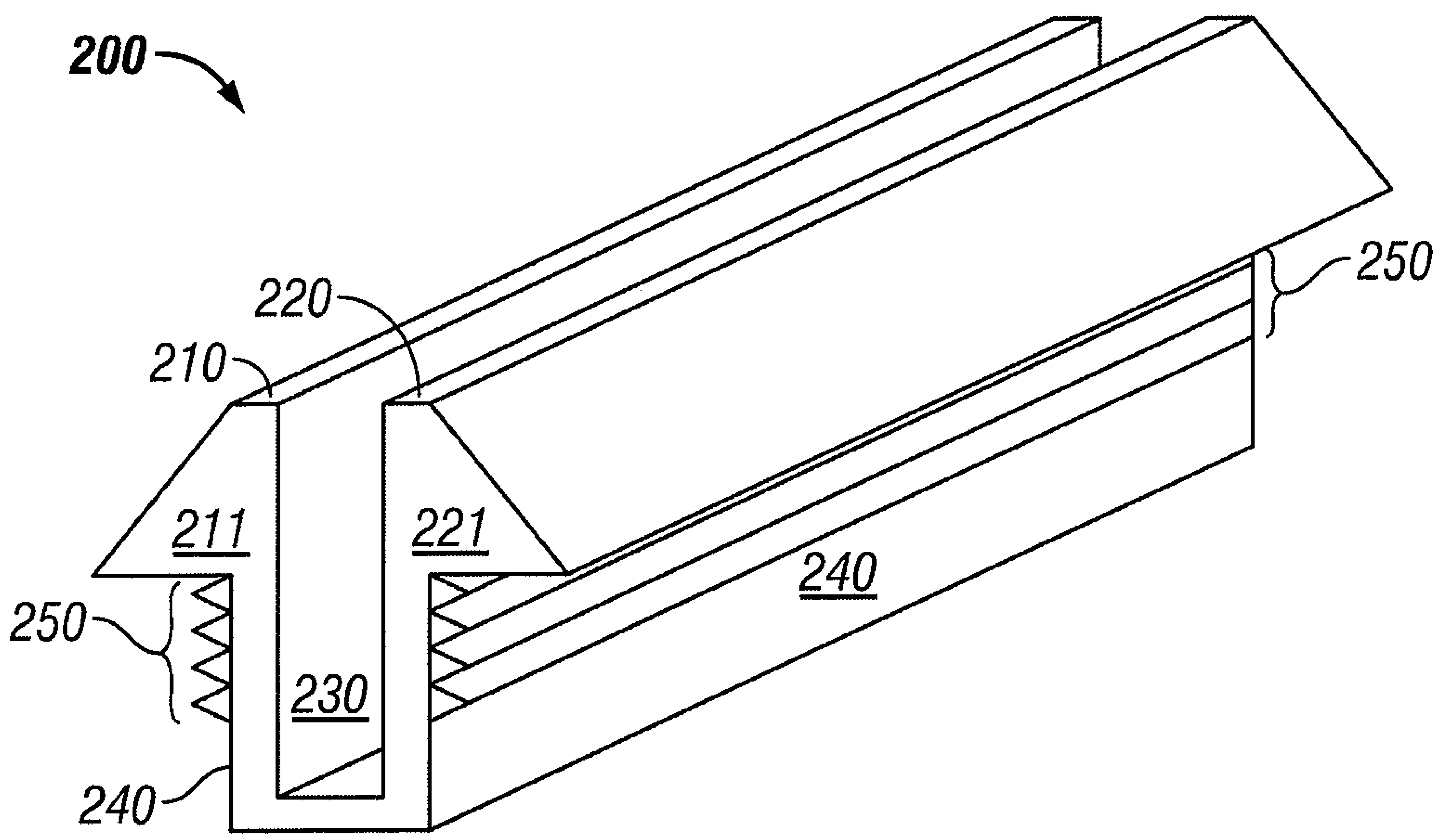
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FIG. 2B

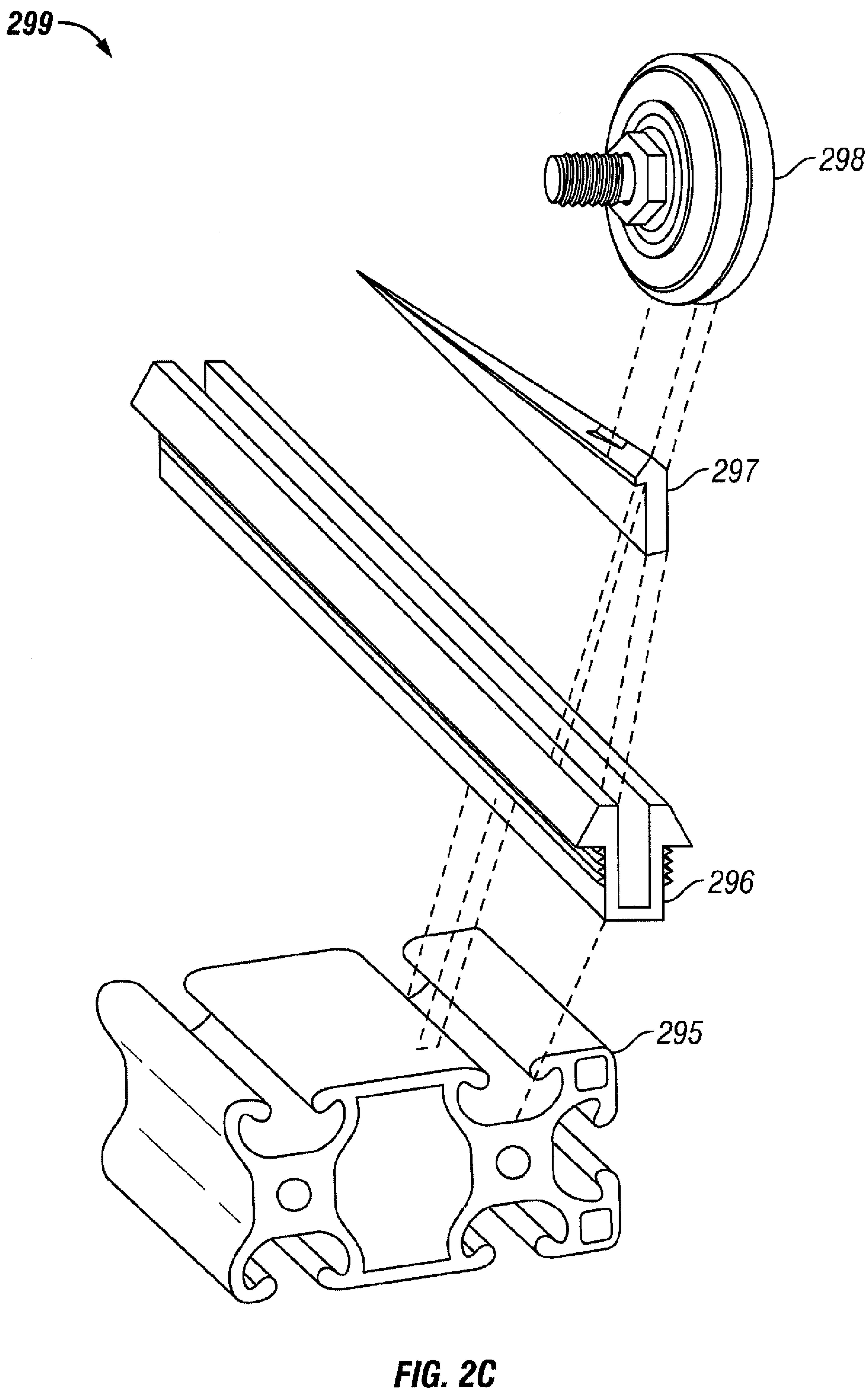

FIG. 2C

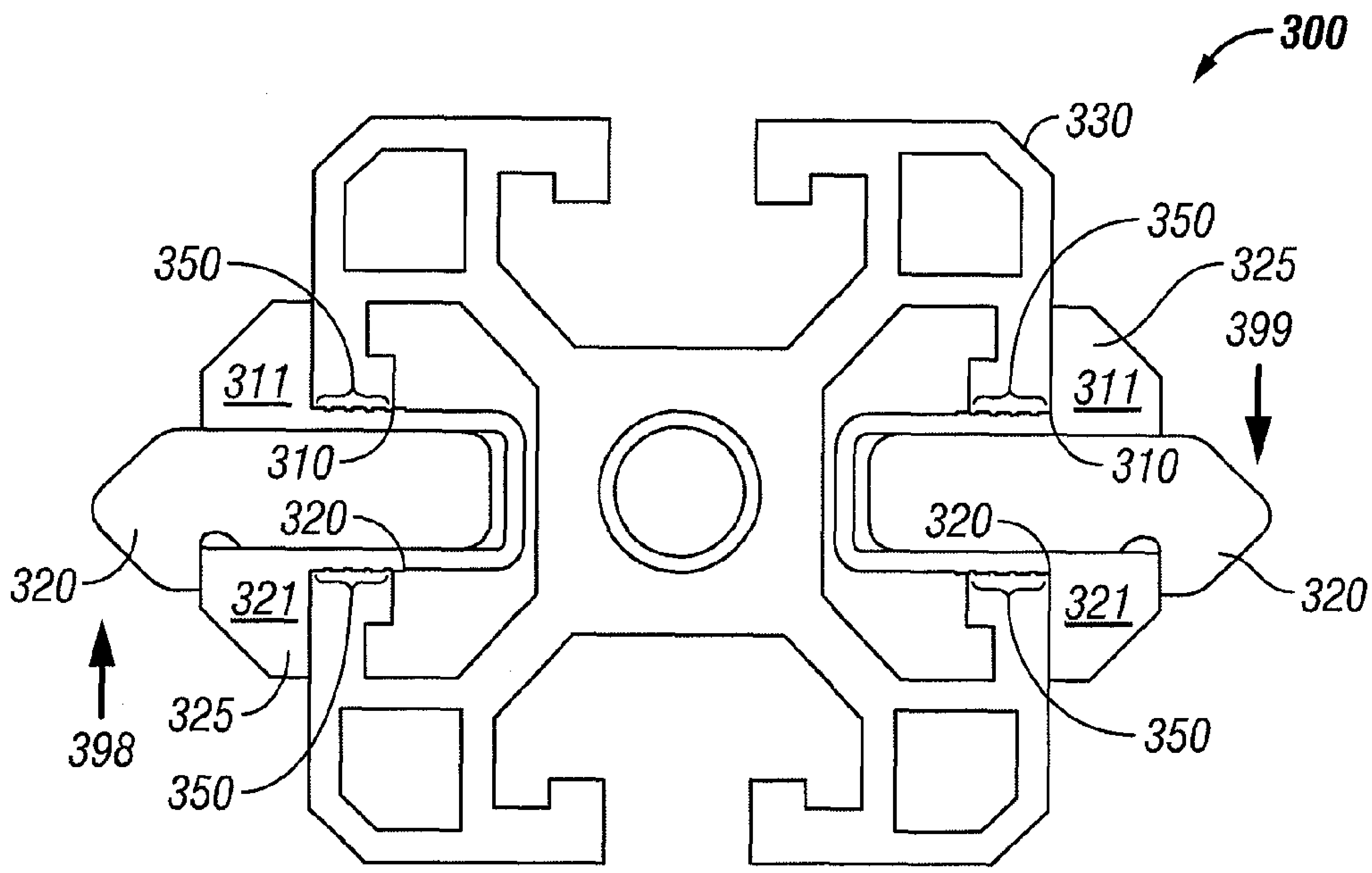
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FIG. 3A

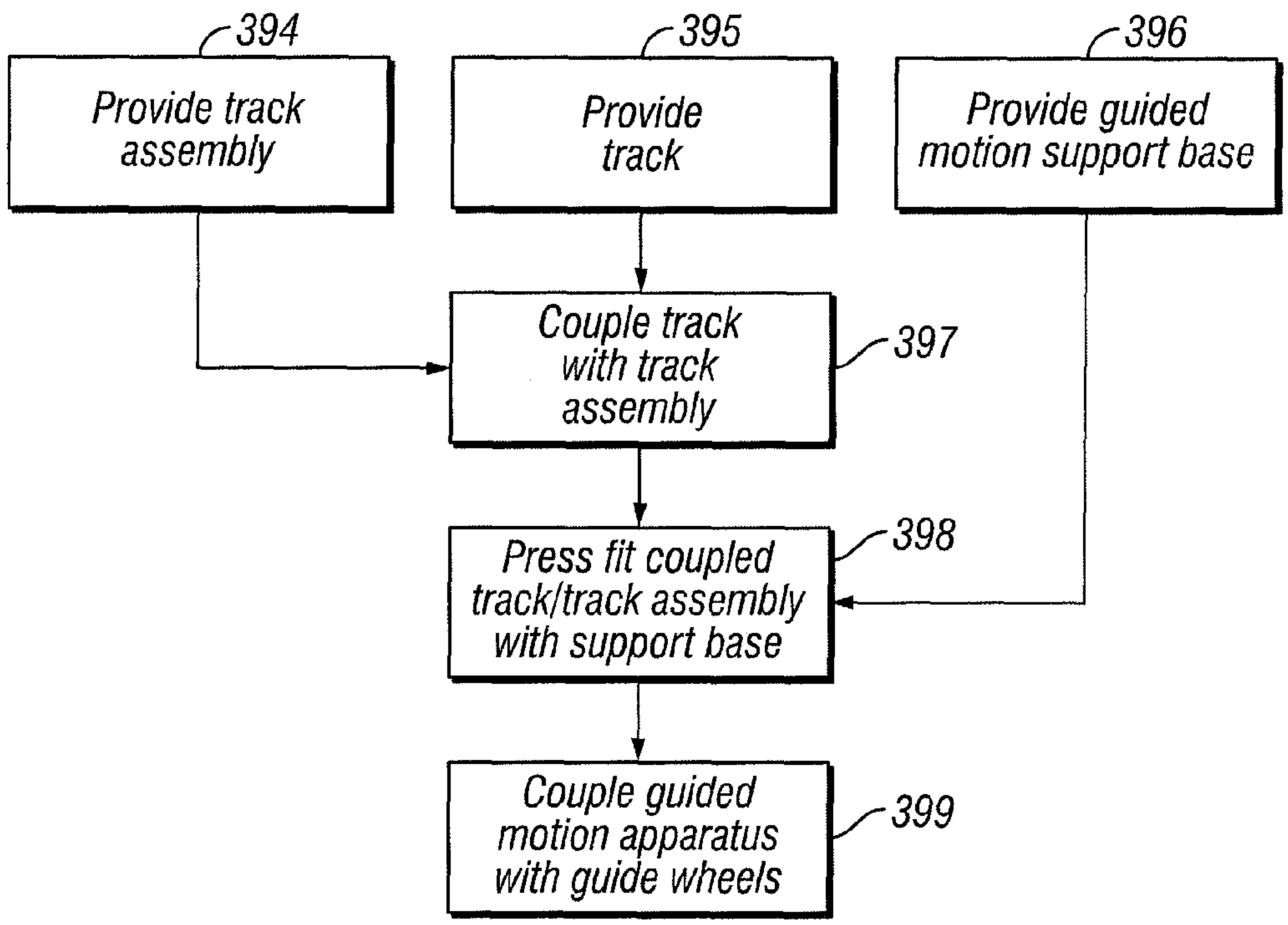
394
Provide track assembly
395
Provide track
396
Provide guided motion support base
Couple track with track assembly
397
Press fit coupled track/track assembly with support base
398
Couple guided motion apparatus with guide wheels
399

FIG. 3B

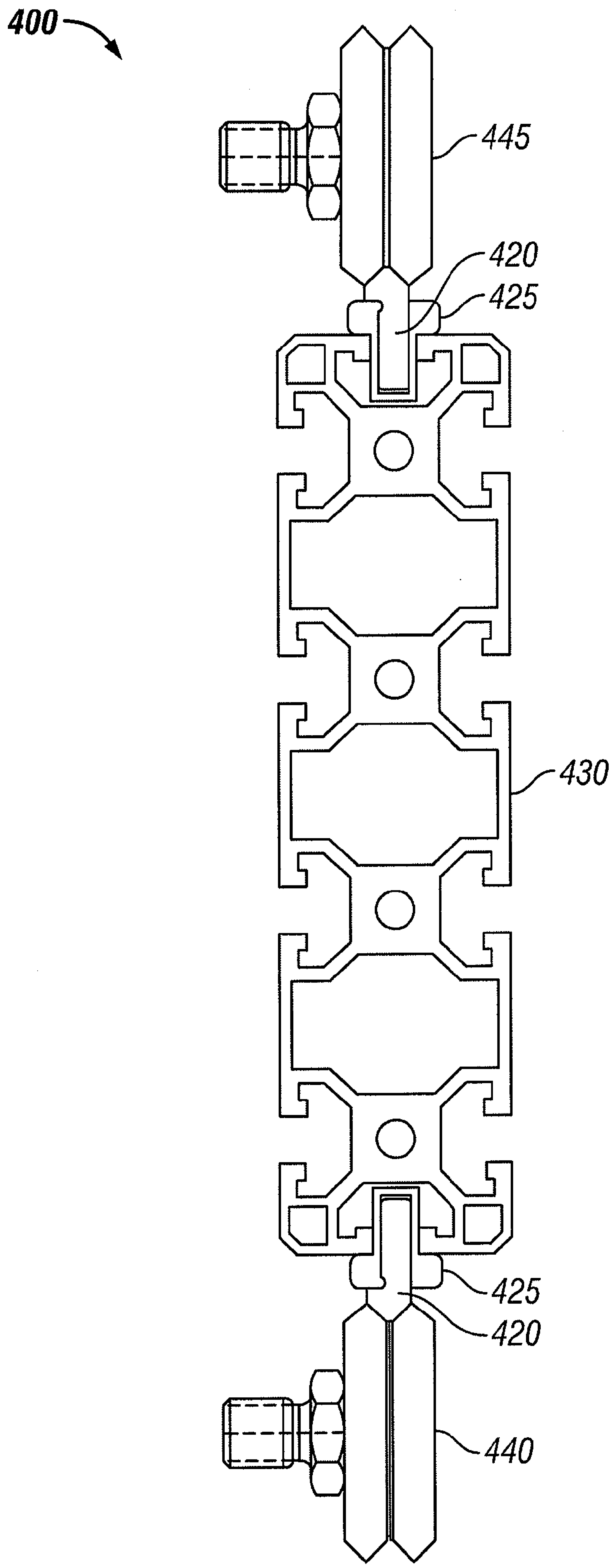

FIG. 4

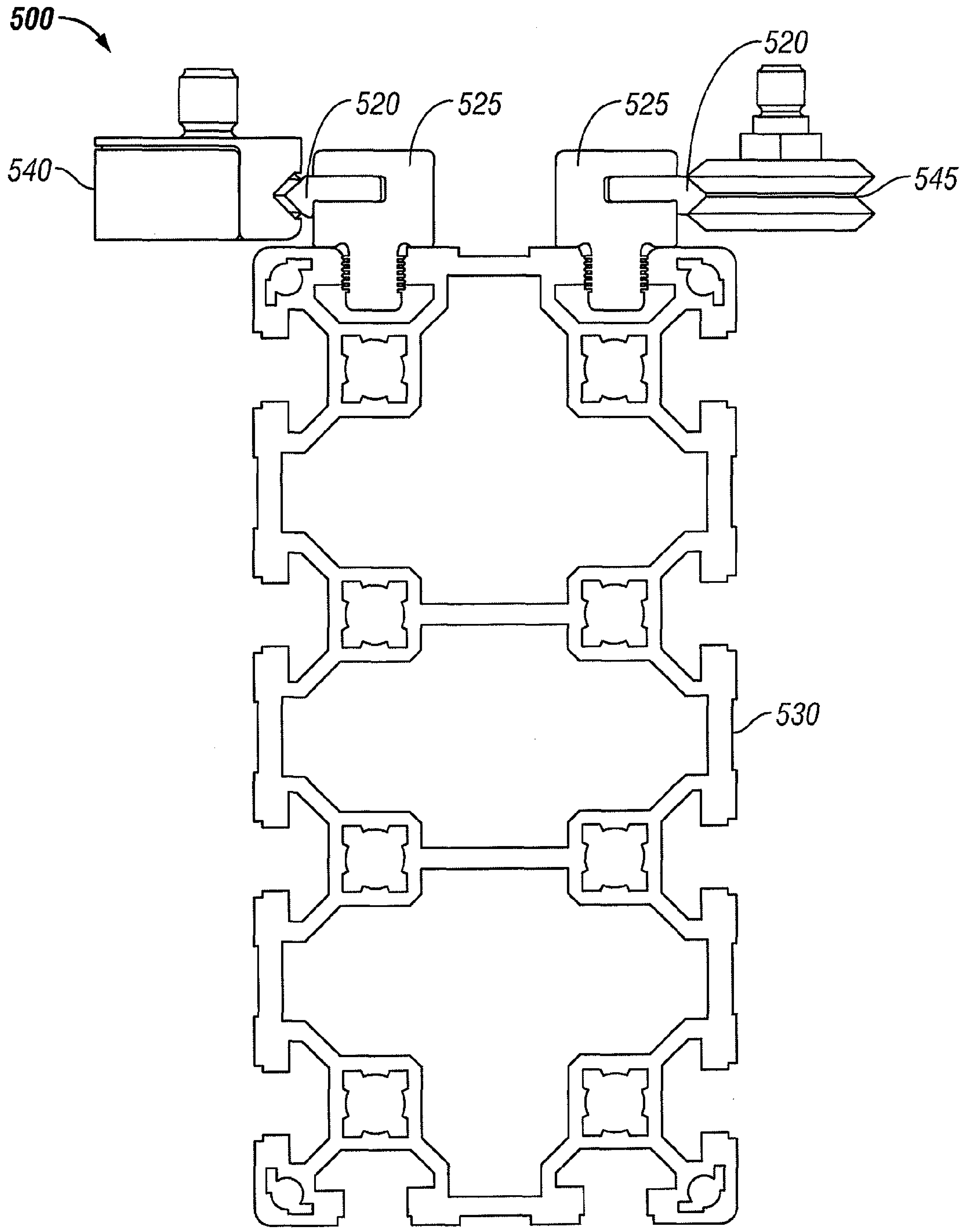

FIG. 5

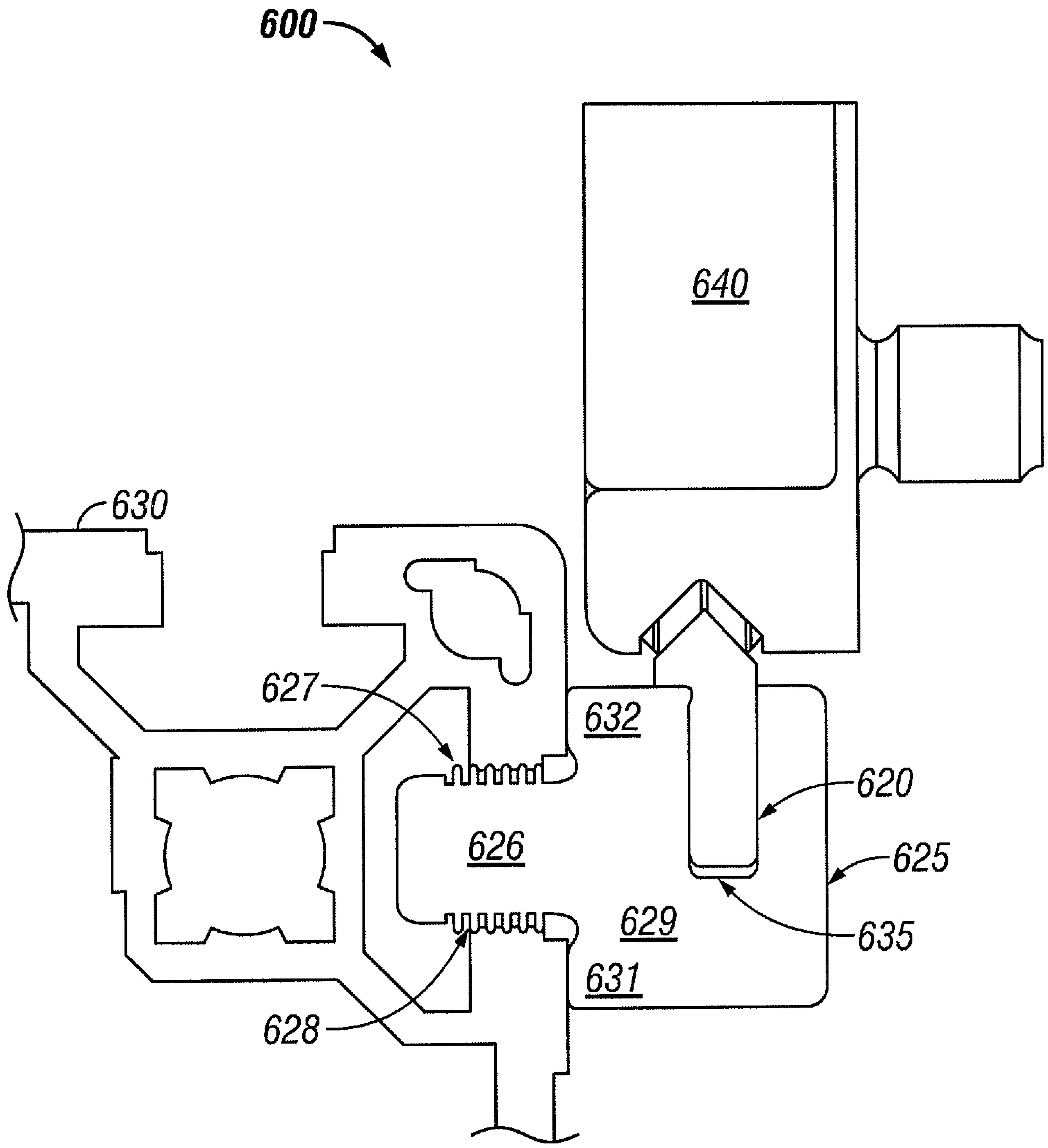

FIG. 6

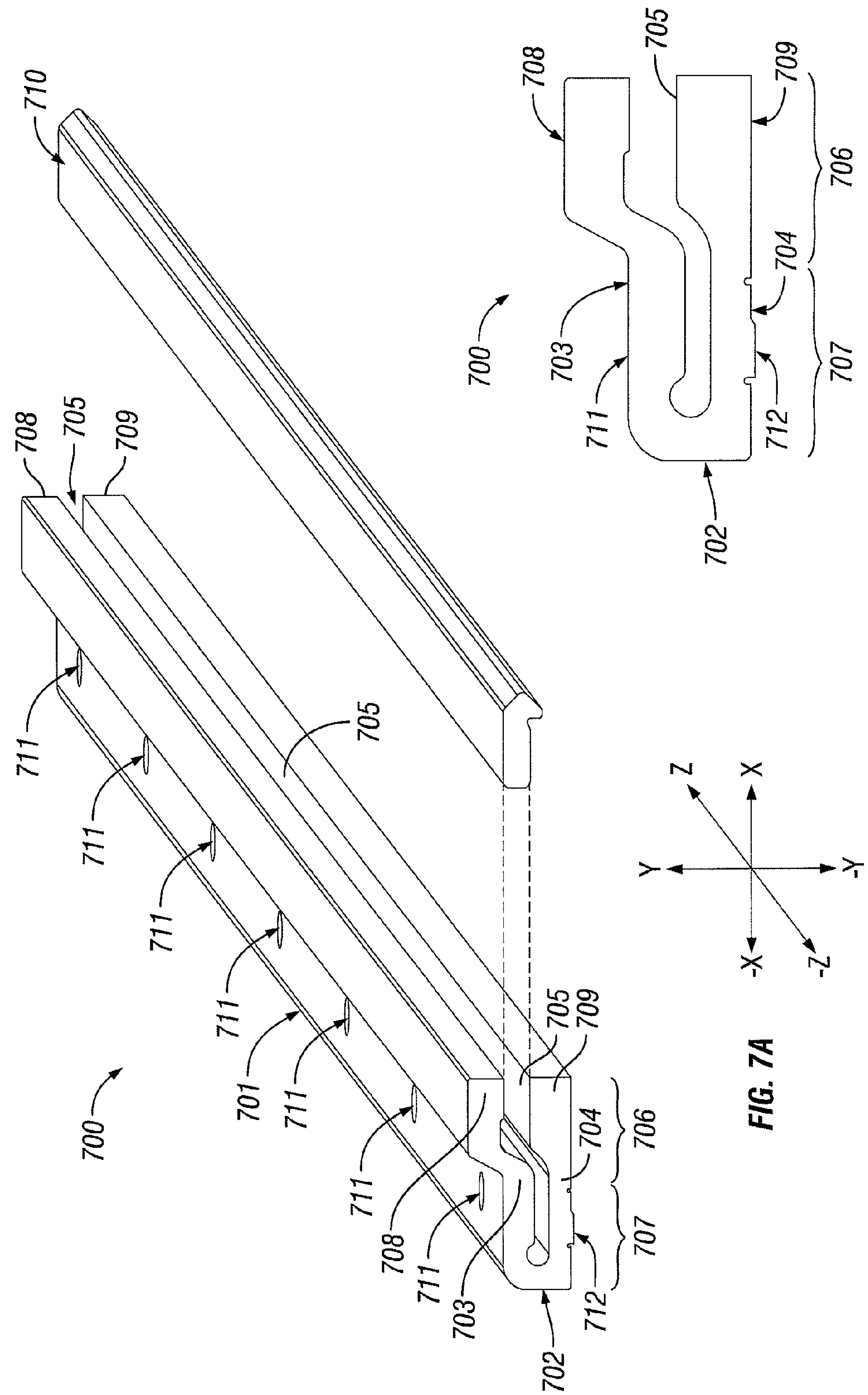

FIG. 7A

FIG. 7B

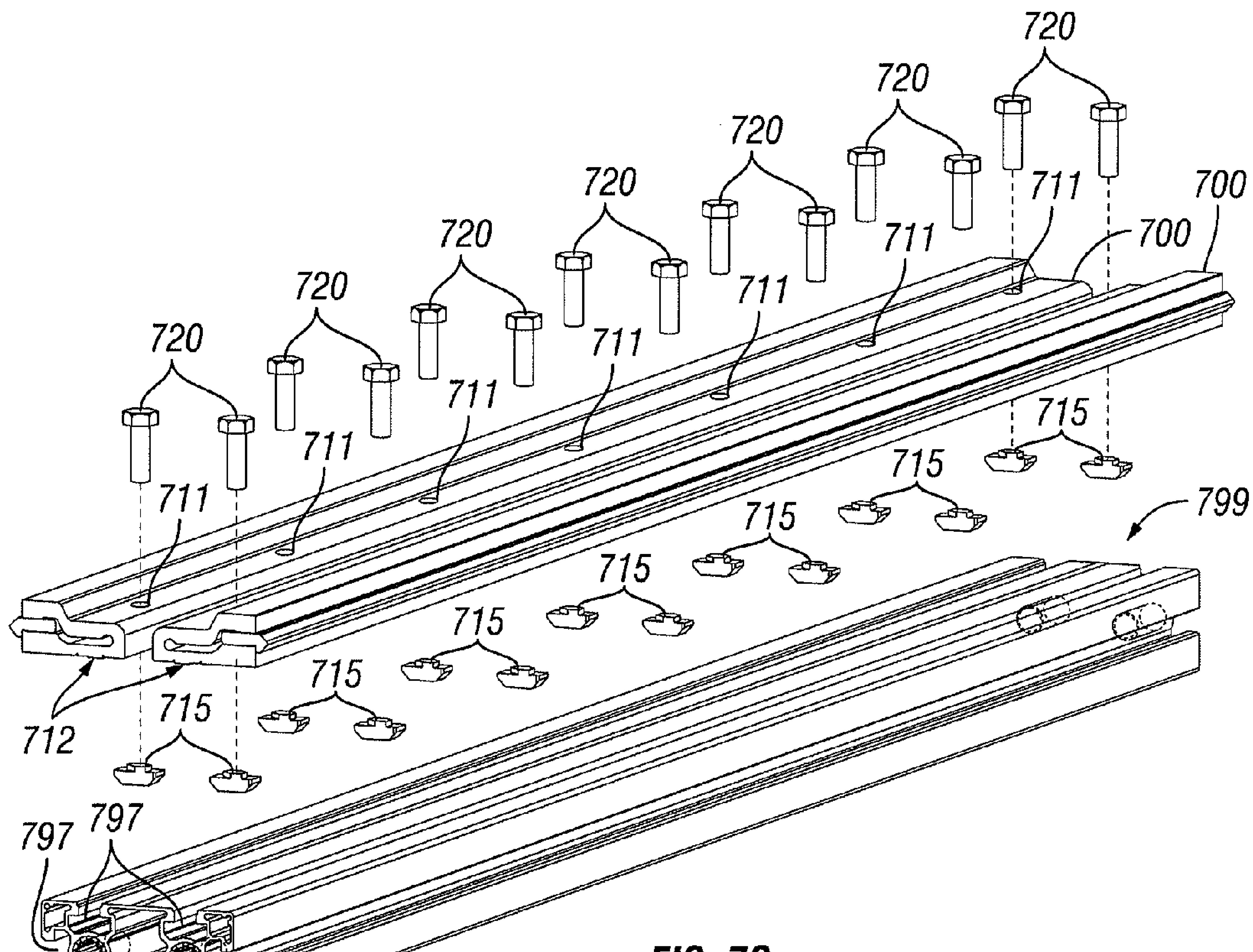

FIG. 7C

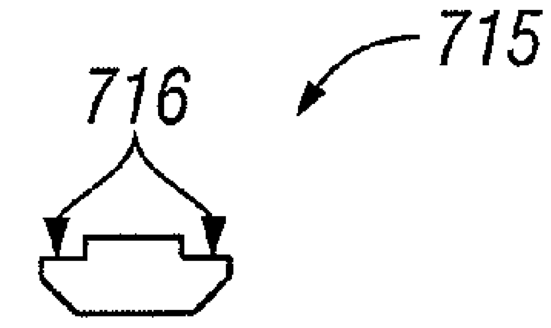

FIG. 7D

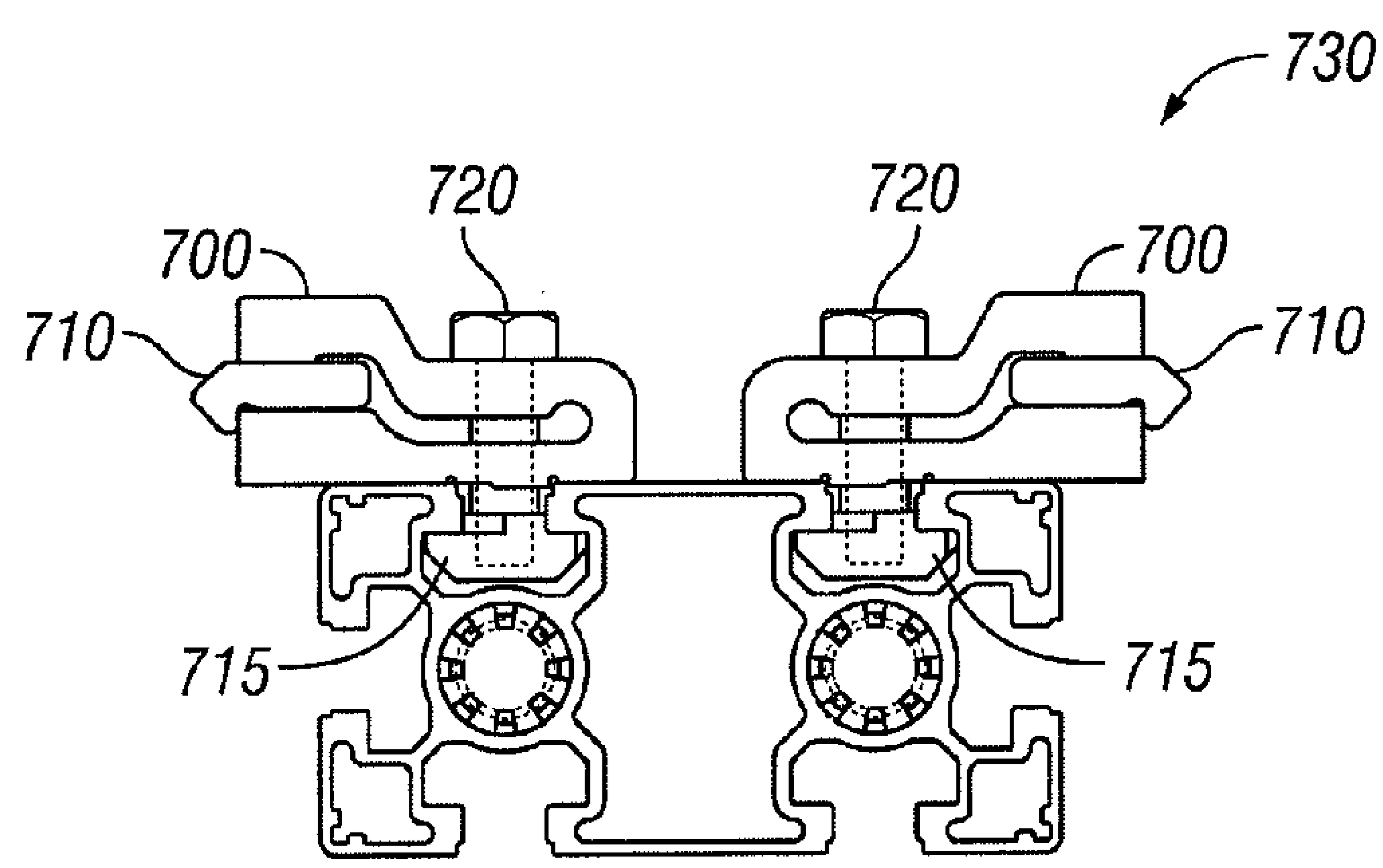

FIG. 7E

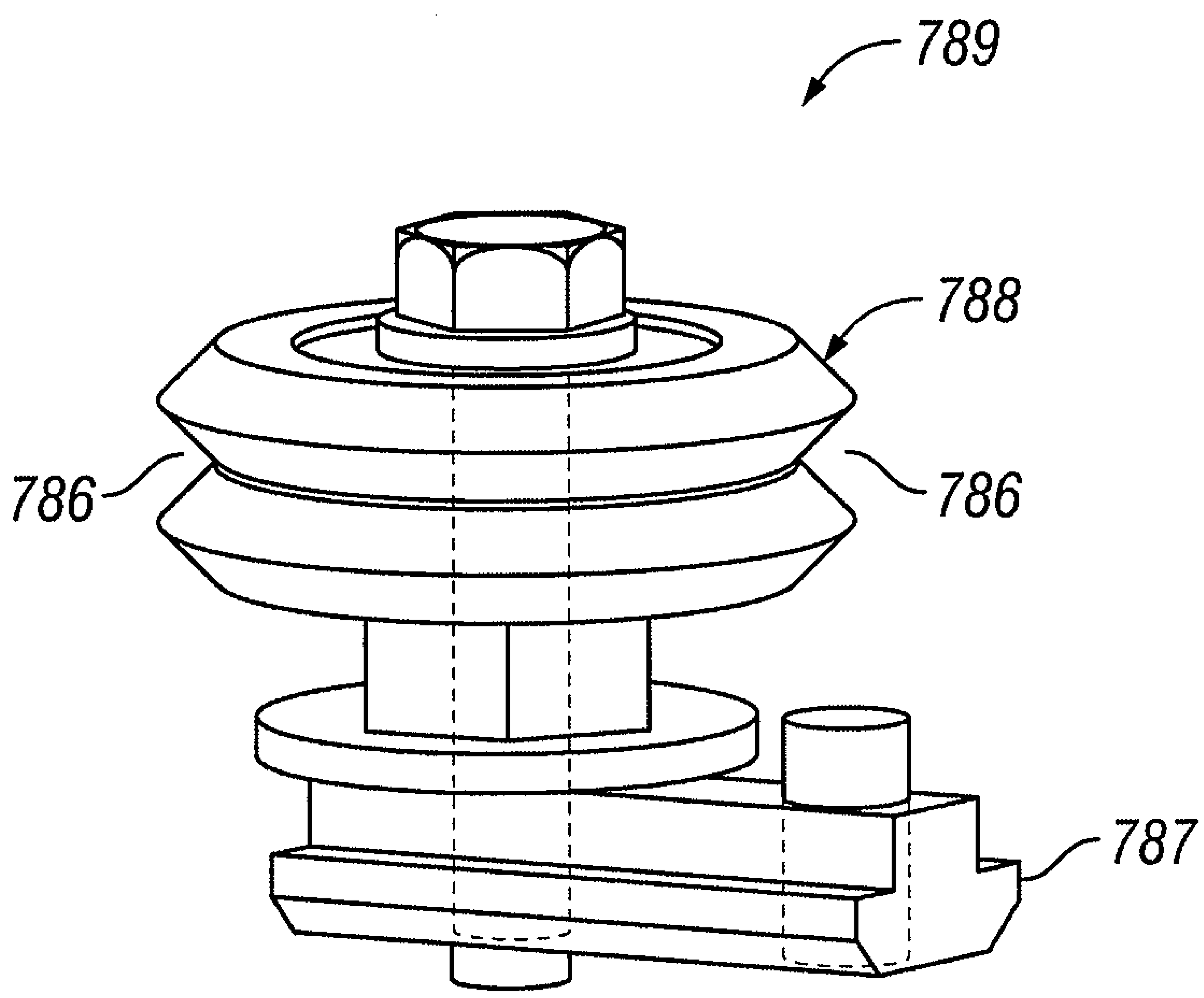

FIG. 7F

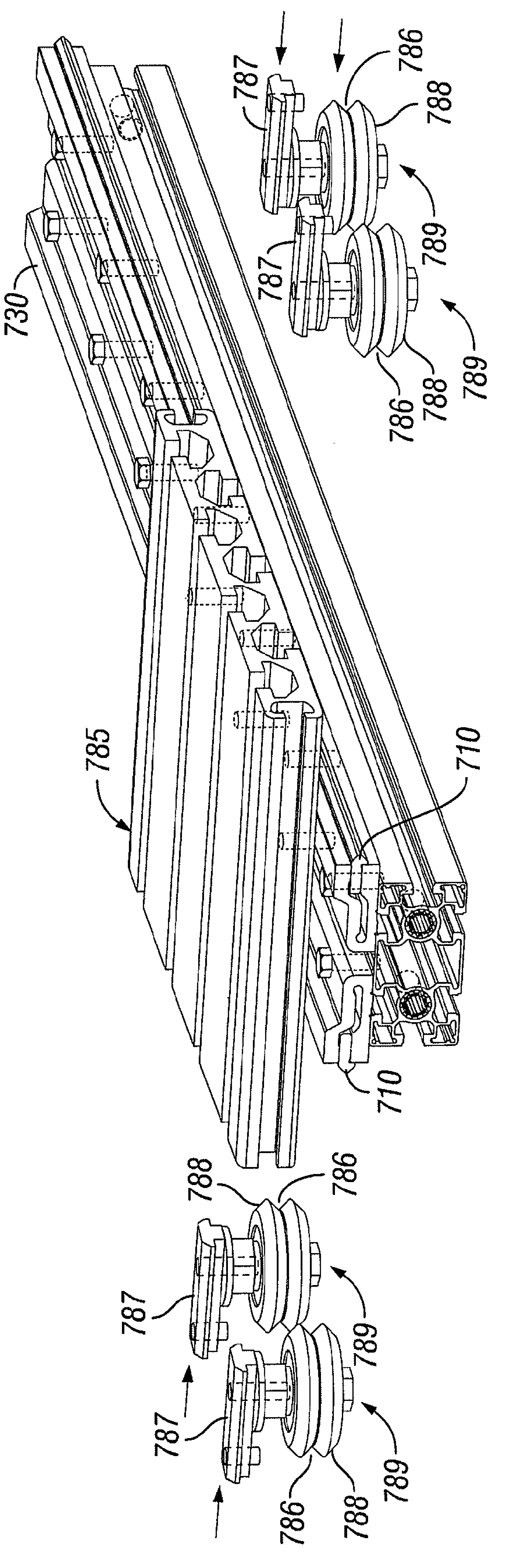

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FIG. 7G

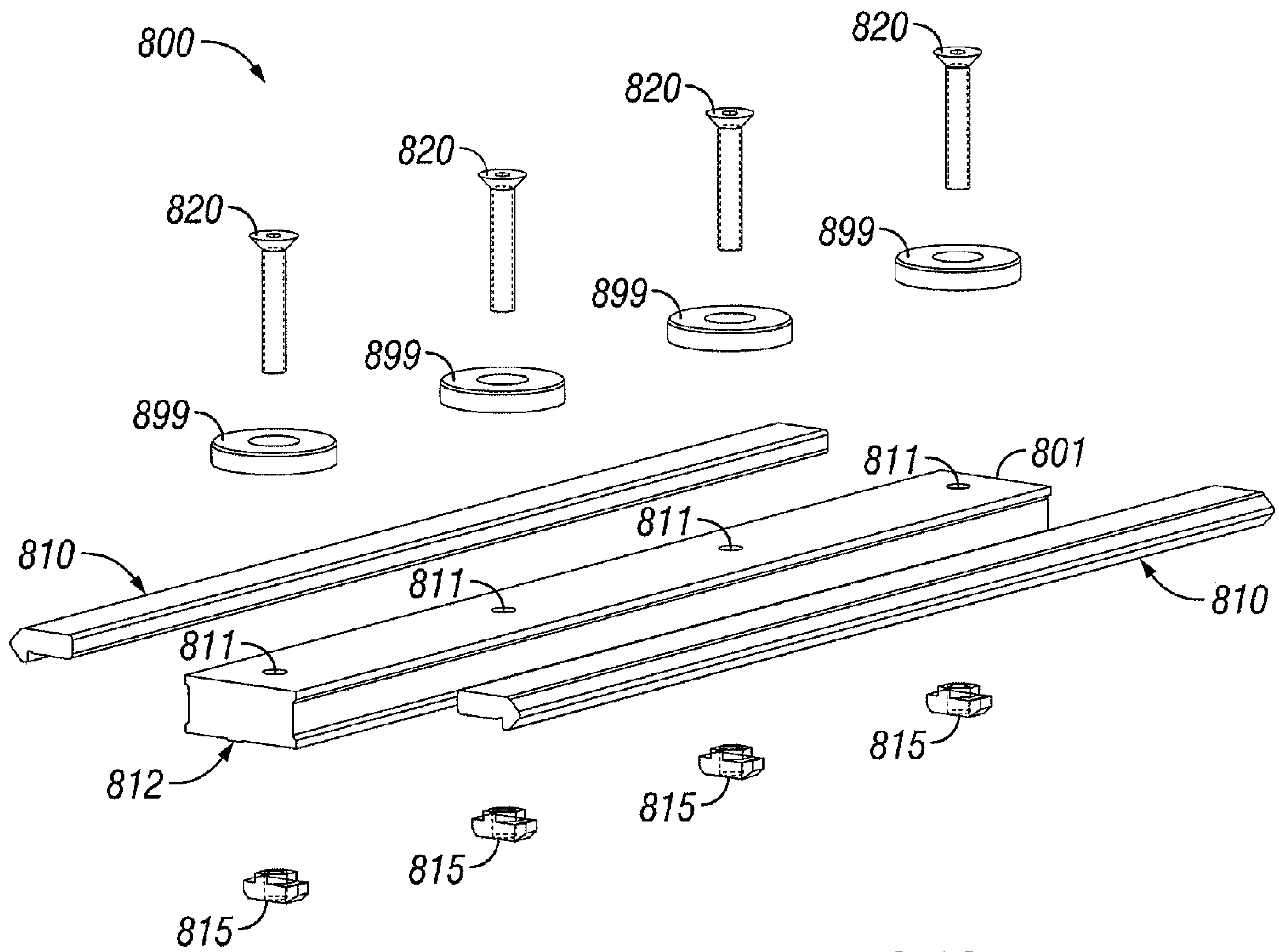

FIG. 8A

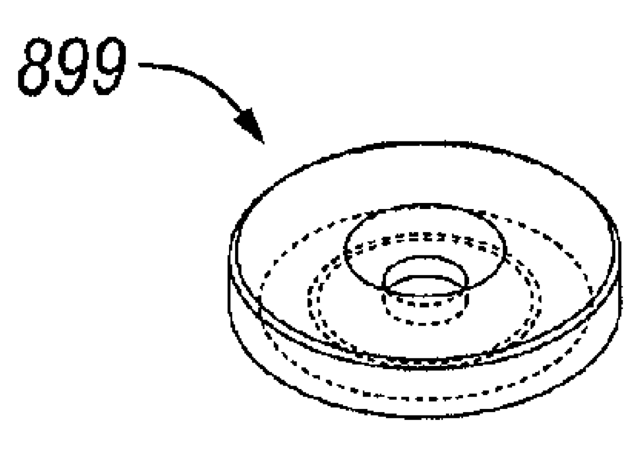

FIG. 8B

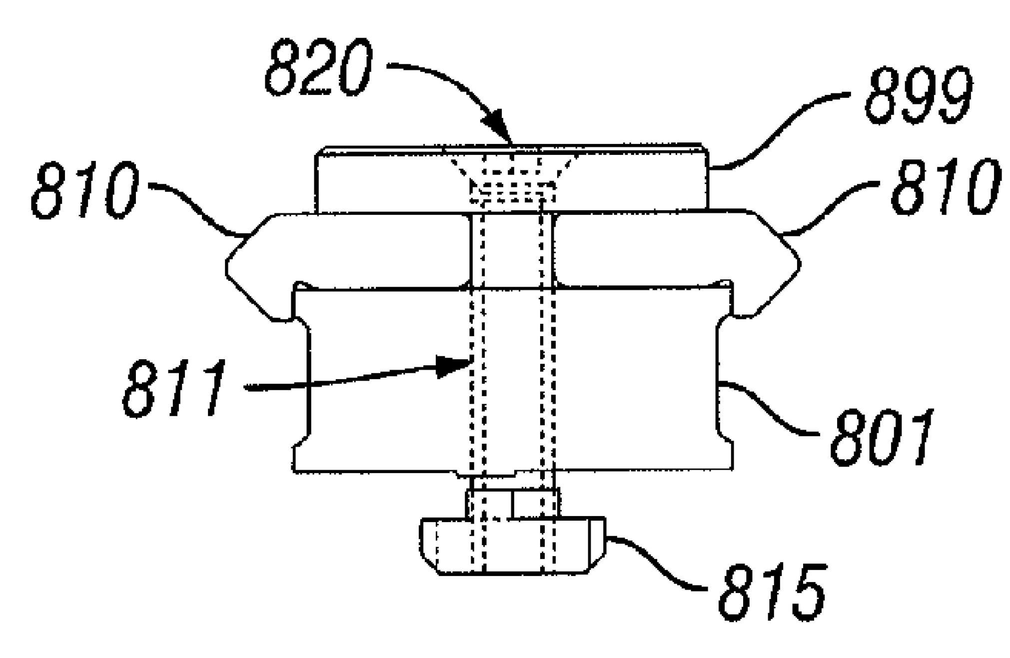

FIG. 8C

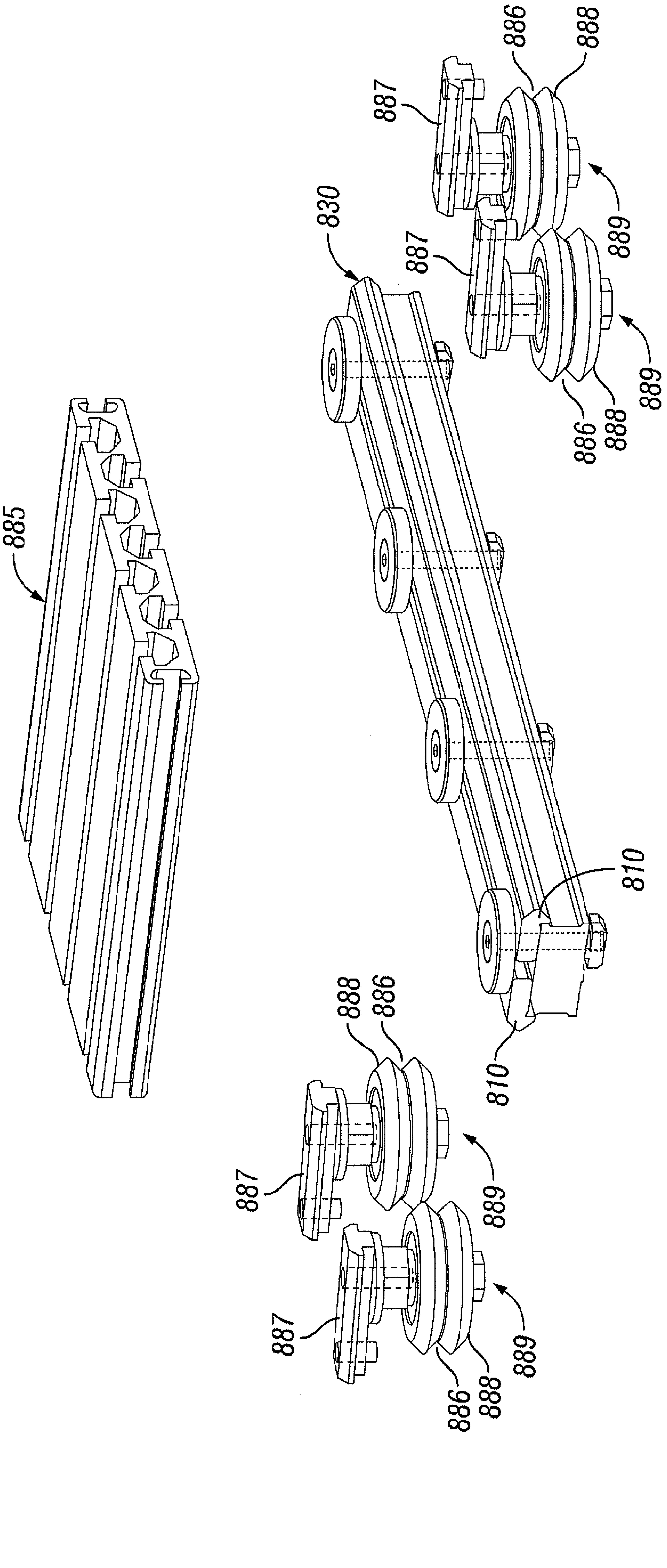
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FIG. 8D

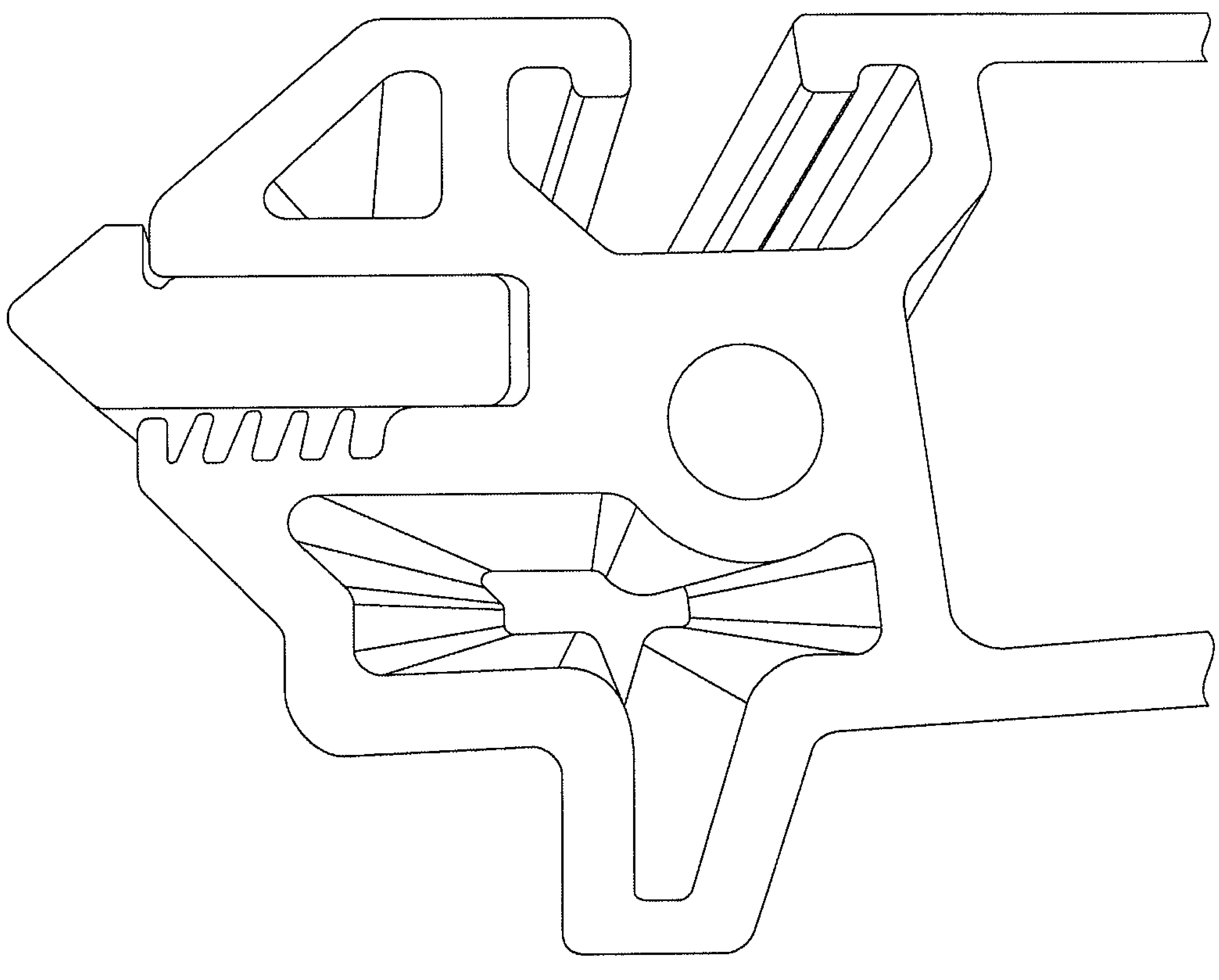

FIG. 9A

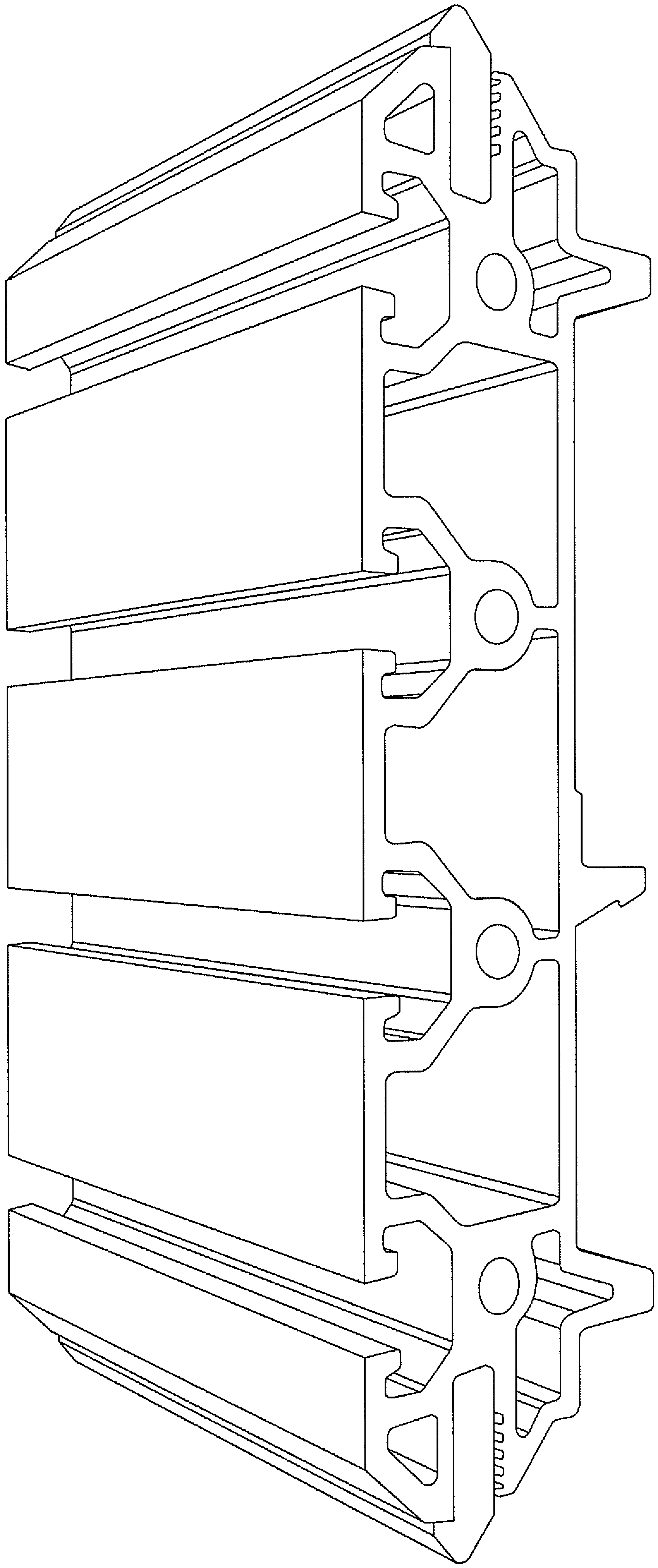

FIG. 9B

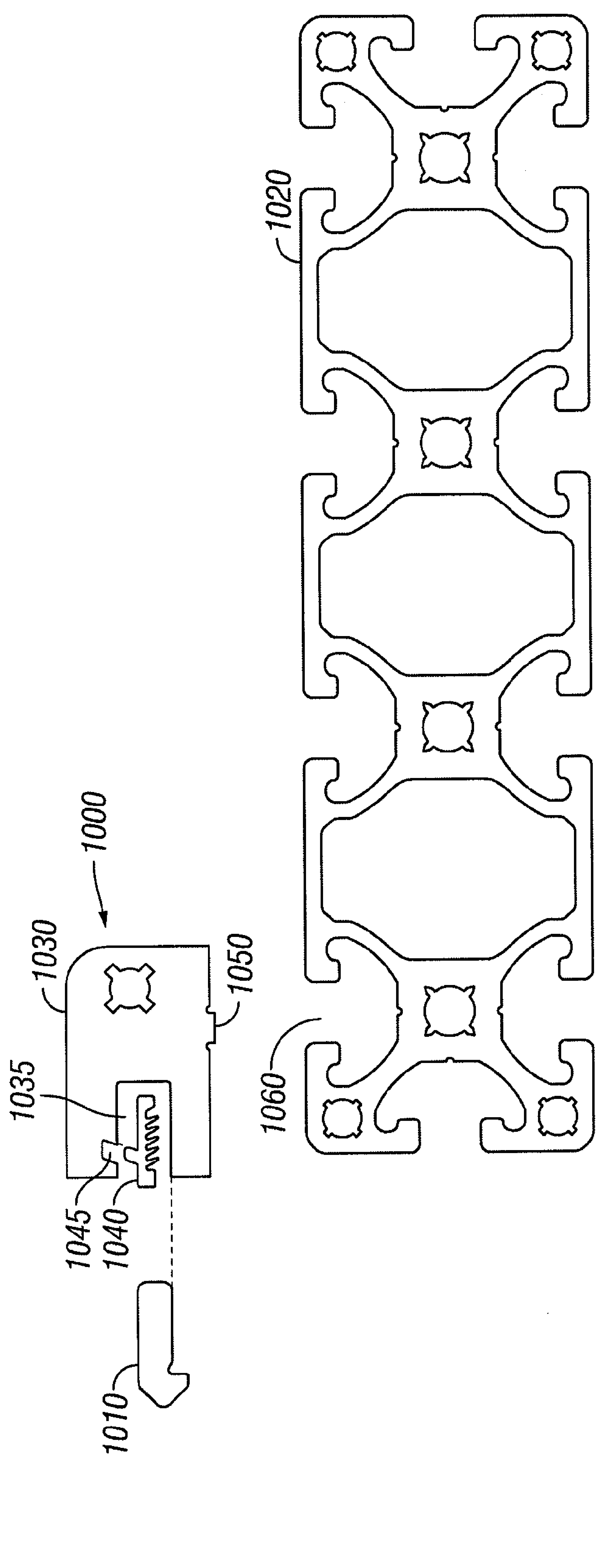

FIG. 10A

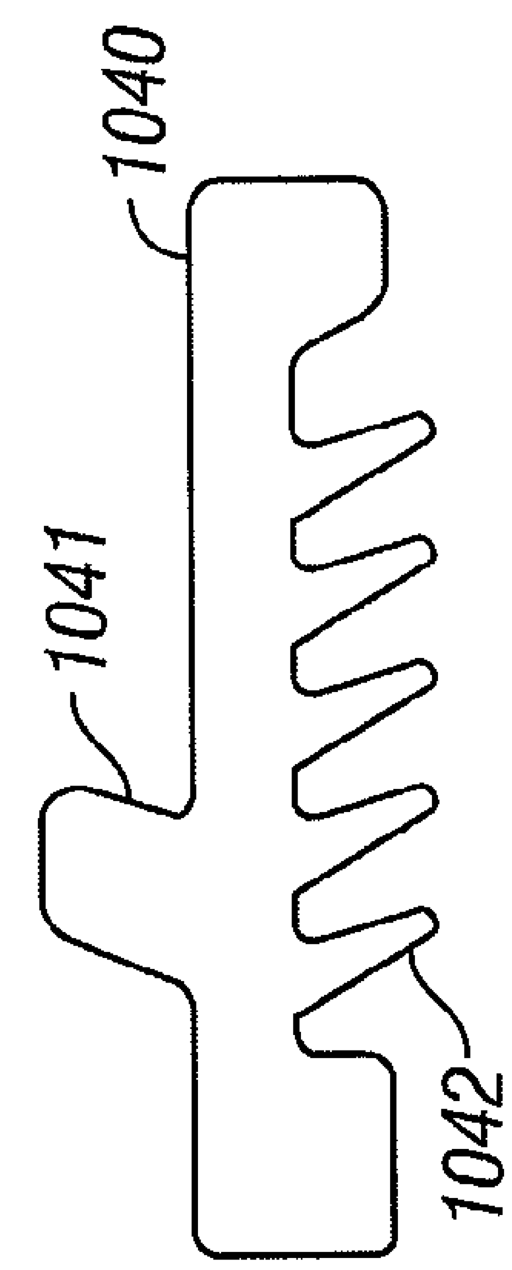

FIG. 10B

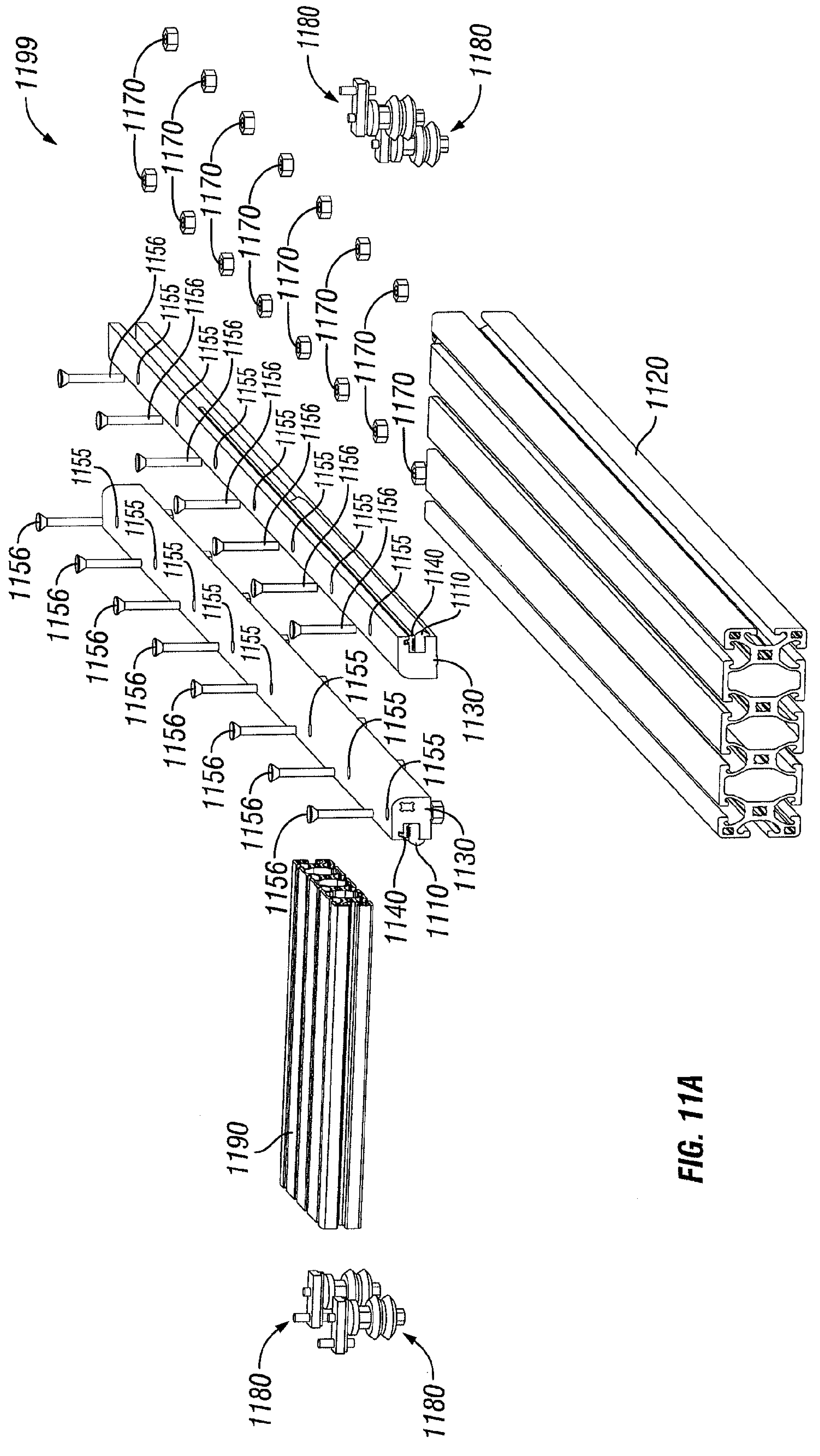

FIG. 11A

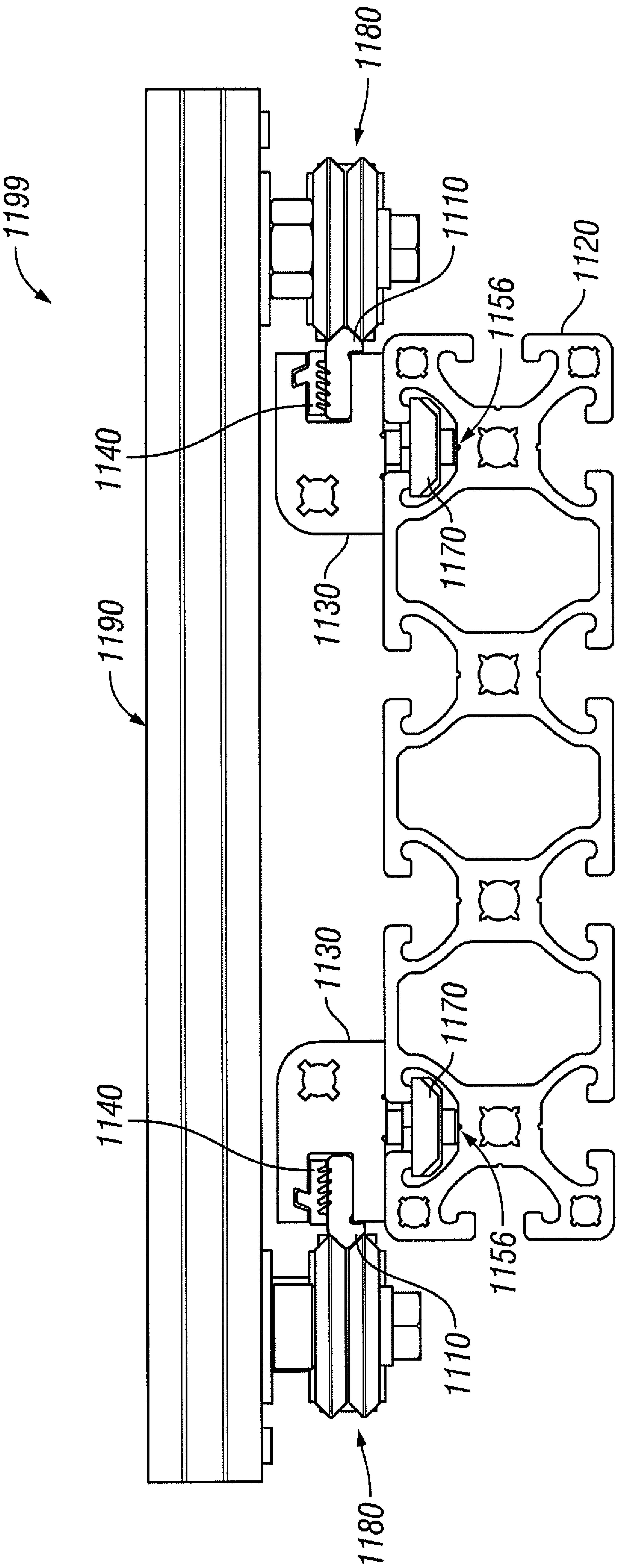
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FIG. 11B

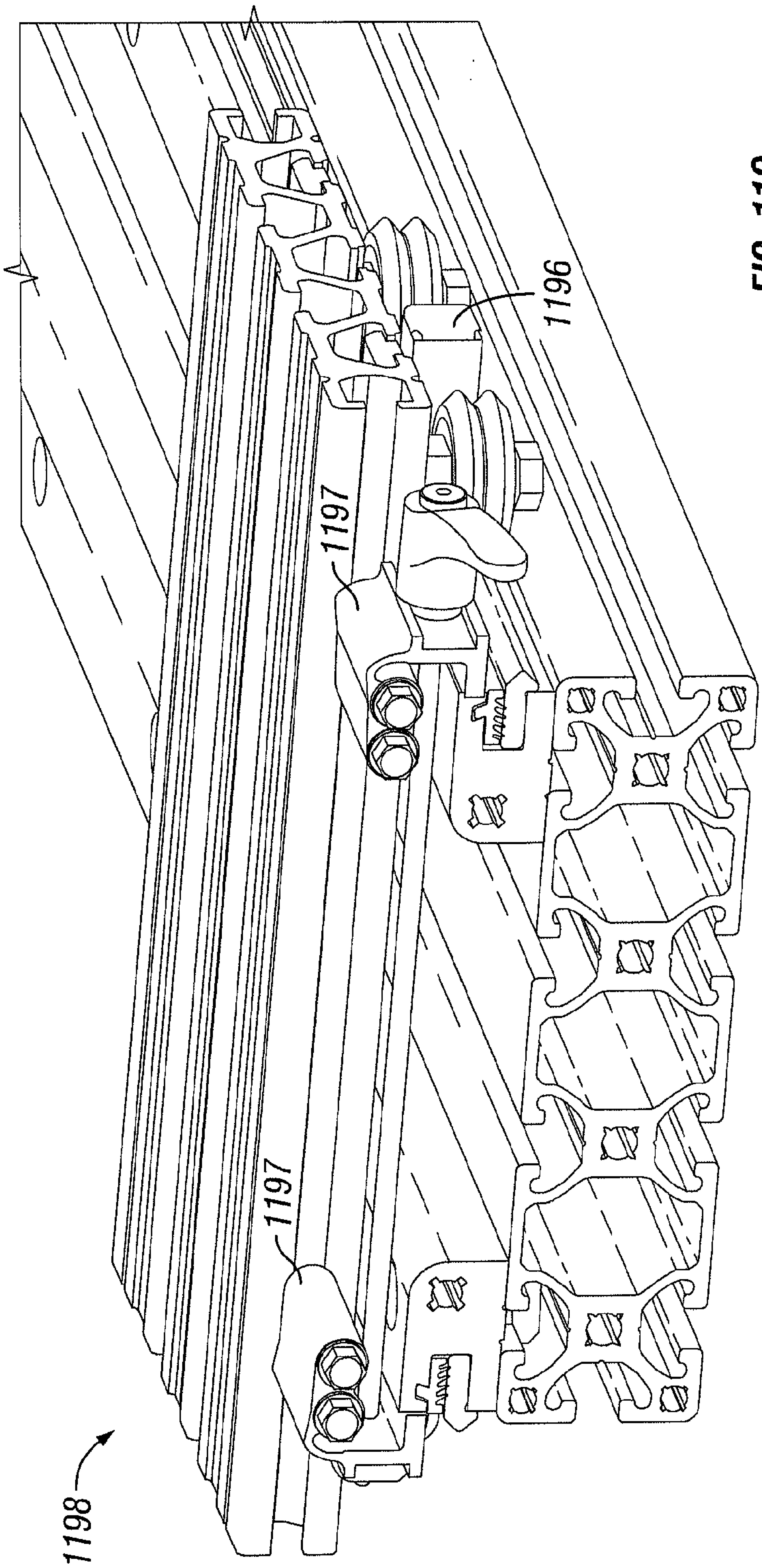

FIG. 11C

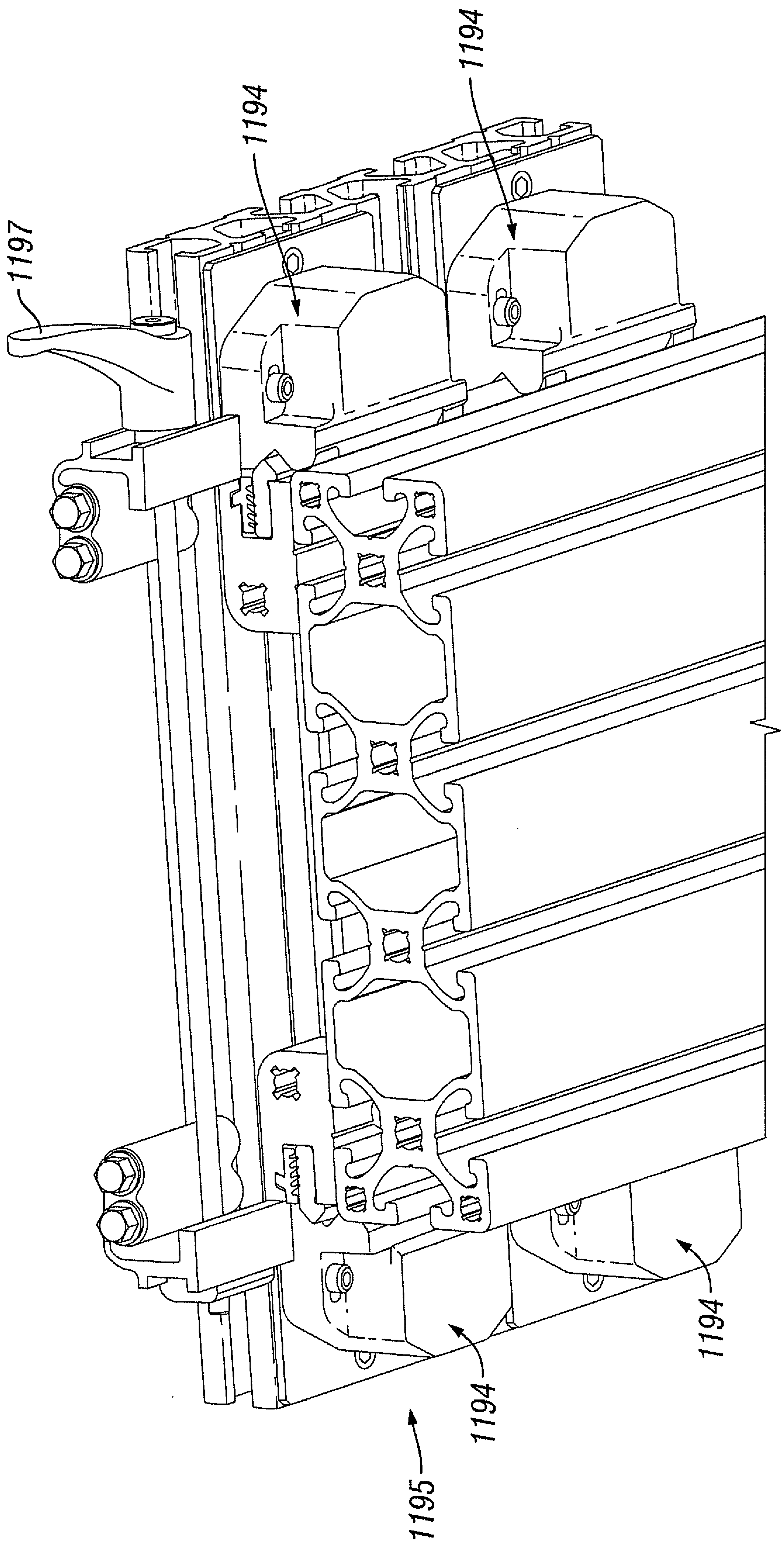

FIG. 11D

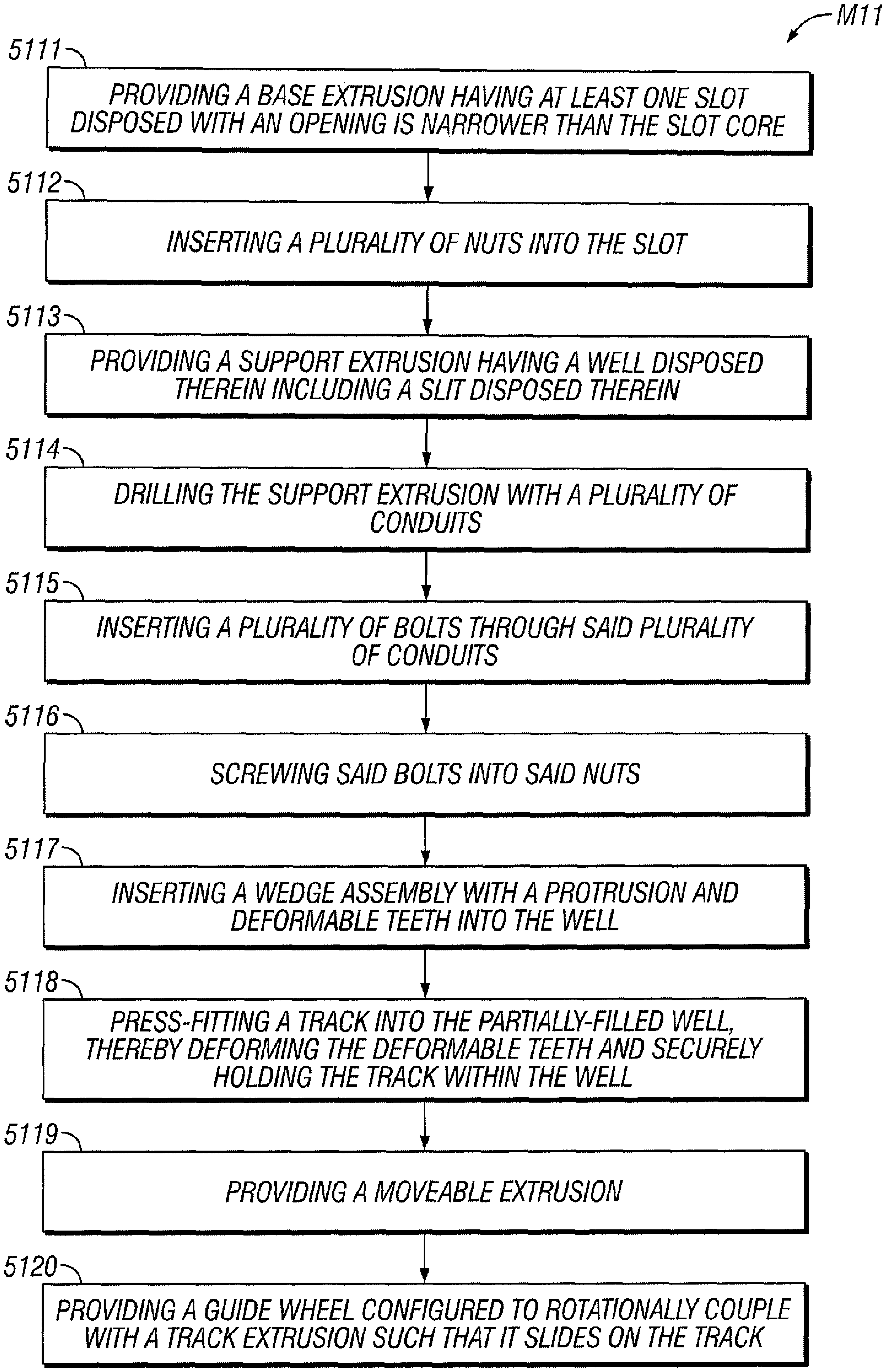
M11
5111
PROVIDING A BASE EXTRUSION HAVING AT LEAST ONE SLOT DISPOSED WITH AN OPENING IS NARROWER THAN THE SLOT CORE
5112
INSERTING A PLURALITY OF NUTS INTO THE SLOT
5113
PROVIDING A SUPPORT EXTRUSION HAVING A WELL DISPOSED THEREIN INCLUDING A SLIT DISPOSED THEREIN
5114
DRILLING THE SUPPORT EXTRUSION WITH A PLURALITY OF CONDUITS
5115
INSERTING A PLURALITY OF BOLTS THROUGH SAID PLURALITY OF CONDUITS
5116
SCREWING SAID BOLTS INTO SAID NUTS
5117
INSERTING A WEDGE ASSEMBLY WITH A PROTRUSION AND DEFORMABLE TEETH INTO THE WELL
5118
PRESS-FITTING A TRACK INTO THE PARTIALLY-FILLED WELL, THEREBY DEFORMING THE DEFORMABLE TEETH AND SECURELY HOLDING THE TRACK WITHIN THE WELL
5119
PROVIDING A MOVEABLE EXTRUSION
5120
PROVIDING A GUIDE WHEEL CONFIGURED TO ROTATIONALLY COUPLE WITH A TRACK EXTRUSION SUCH THAT IT SLIDES ON THE TRACK

FIG. 11E

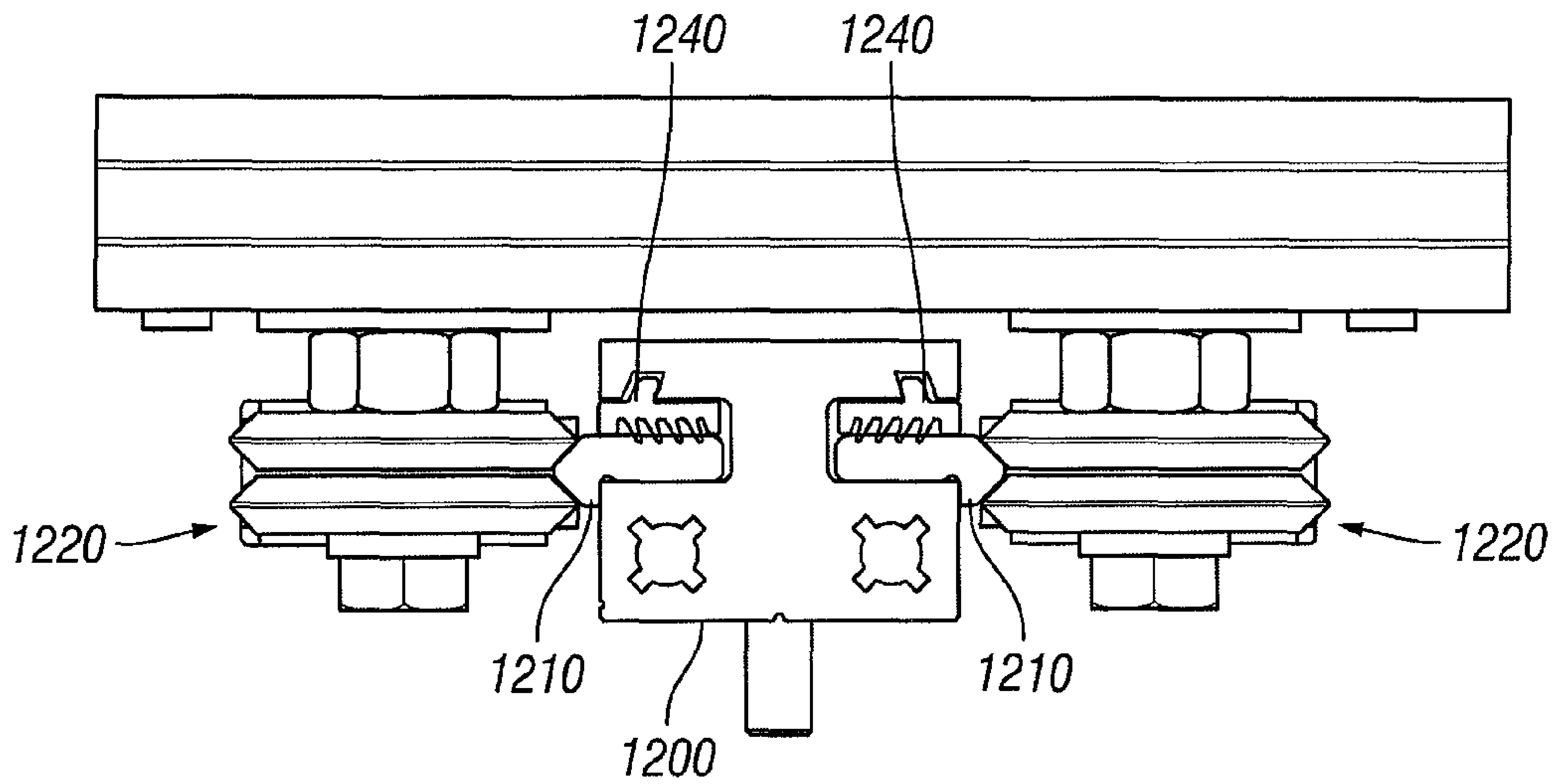

FIG. 12A

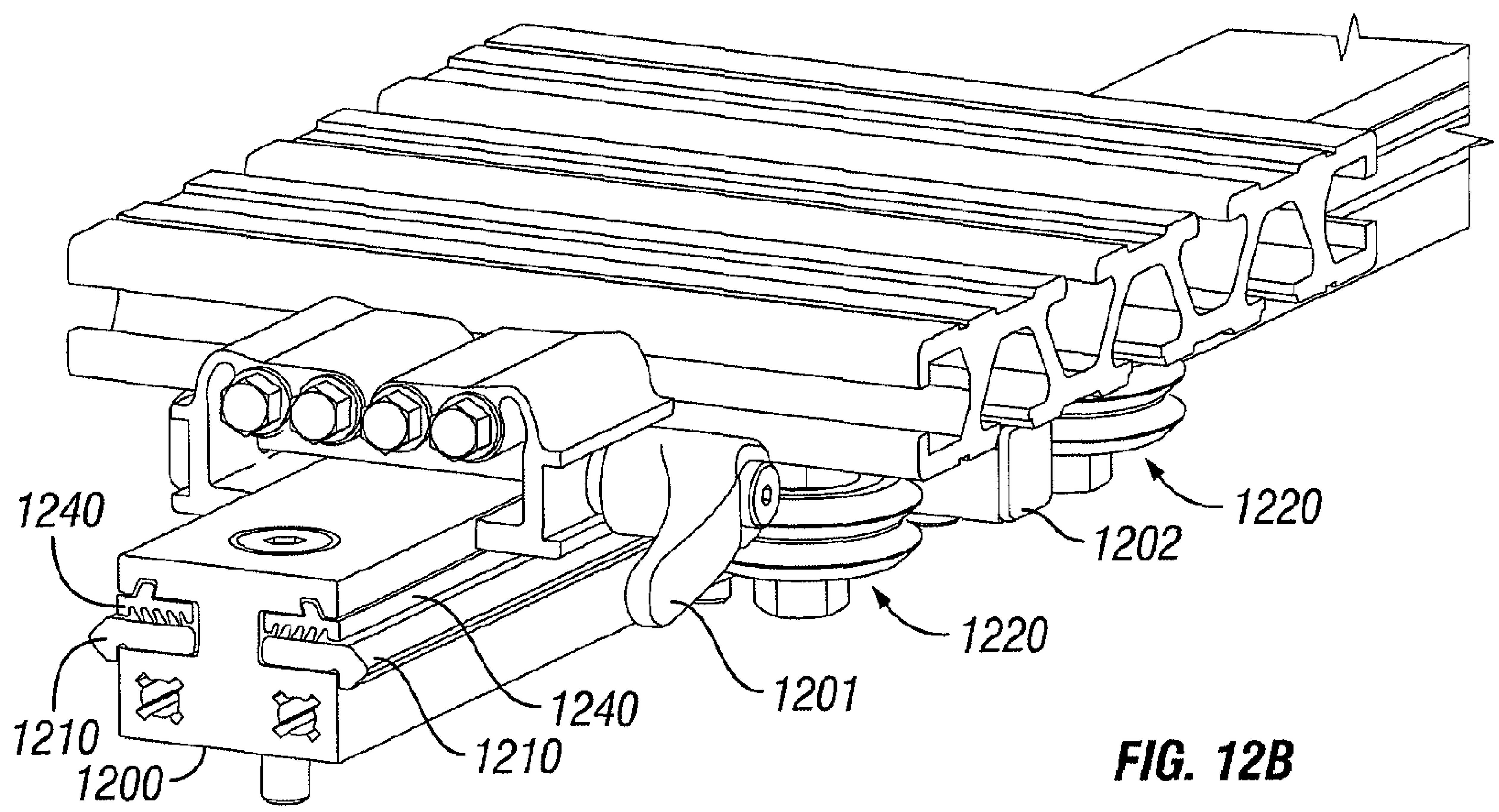

FIG. 12B

SYSTEM FOR HOLDING A LINEAR MOTION GUIDE TRACK TO A SUPPORT BASE AND METHOD THEREFOR

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a continuation-in-part application of application Ser. No. 12/643,785, filed Dec. 21, 2009 now U.S. Pat. No. 8,434,946, which is a continuation-in-part application of application Ser. No. 12/260,754, filed Oct. 29, 2008 now U.S. Pat. No. 8,491,193, each of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Technical Field

The invention relates generally to assembling a linear track in a guided motion system. In particular, the invention relates to a track assembly that provides a quick and easy method of assembly of linear motion guide tracks to standard base extrusions.

2. Description of the Prior Art

In manufacturing processes and within manufactured capital goods themselves, precise and repeatable motion is useful and often essential. For example, in manufacturing processes ranging from machining to textiles to electronics, tool heads or other items move back and forth and must do so precisely and repeatedly over enormous numbers of cycles. In other settings, specimens and instrumentation move relative to each other within laboratory analytic devices to collect data on the samples and must do so precisely and repeatedly.

Linear motion guides are used extensively in manufacturing processes and other applications to produce precise reciprocating motion cycles. Linear motion guides are typically supported on extruded support bases. For example, FIG. **1** shows a widely available aluminum extrusion support base 130 manufactured by the Parker Hannifin Corporation, located in Cleveland, Ohio. Similarly, guide tracks and guide wheels are widely available standard articles of manufacture. For example, DualVee® guide wheels and Single Edge guide tracks, both manufactured by Bishop-Wisecarver Corporation, are time-tested and ideal for a wide variety of applications.

Guide wheels attached to support bases and riding on rails are one class of guided motion technology that provides precise and repeatable kinematics. For example, U.S. Pat. No. 3,661,431 discloses guide wheels and tracks in which guide wheels cooperate with rails such that the guide wheels may move along the rails.

An exemplary guided motion assembly is shown in FIG. **1** and comprises a V-shaped guide track **120** and a DualVee® guide wheel **110** both manufactured by Bishop-Wisecarver Corporation, located in Pittsburg, Calif. The track **120** is coupled with a support base **130** using track clamp **125**. In the illustrated embodiment of the invention, the support base **130** comprises an extrusion.

Known support bases are typically available in a standard sizes and configurations. For example, the support base **130** shown in FIG. **1** may be an extruded aluminum support base, such as that manufactured by Parker Hannifin Corporation.

Also widely used in the guided motion industry are track clamps for coupling the track with the support base. FIG. **1** illustrates a known track clamp **125** for coupling the V-shaped guide track **120** to a standard extrusion **130**. Previous attempts of providing track clamps for standard support bases have been complicated, time consuming, difficult to assemble due to the need for fasteners, expensive to assemble, and unreliable due to the use of moving parts, among other shortcomings. Indeed, there are many disadvantages to the current state of the art.

Due to the deficiencies of the prior art, there is a need to provide a reliable, effective and easy-to-assemble guide track system for coupling guide tracks with linear motion support bases.

There is also a need for a method of manufacturing guide tracks that effectively couple with a standard support base without the use of fasteners. Additionally, there is a need to provide methods of assembling guided motion systems without using traditional fasteners.

Likewise, in applications in which the use of fasteners is preferable, there is a need for uncomplicated, easy-to-assemble, reconfigurable, and universally faster systems.

One drawback of the prior art is that linear guide tracks that use fasteners and track clamps are commonly designed for use with a specific base extrusion. For example, many known linear guide tracks are specifically designed to work with the various T-slot extrusions manufactured by Parker Hannifin Corporation. However, such specifically designed track assemblies cannot be used with other extrusion bases or configurations. Therefore, there is a need in the art for a guide track assembly that can be used with any extrusion having a T-slot configuration.

Another drawback to the prior art is that known solutions oftentimes require that the end user cut, drill, or otherwise machine a set of work pieces to initially configure a linear guide system. This is problematic for end users who do not possess a sophisticated machine shop or for those who do not possess the requisite skill to fabricate the required materials.

Furthermore, pre-drilled track is very expensive and requires a user to layout the substrate to which the track is to be assembled in advance. This too is problematic because the user must be especially precise and must have detailed plans well in advance. Moreover, once one particular setup is configured, it cannot be reconfigured without taking apart the entire system and re-drilling.

Another drawback to current linear motion systems is the width profile of a track assembly. For example, known linear motion guides are bulky.

Another significant drawback of the known art is that drilling track and attaching it to a substrate with a plurality of individual fasteners oftentimes results in undulations and imperfections in the linear track. These undulations can negatively affect the entire system.

Likewise, it is difficult to maintain parallelism of the tracks when fastening a guide track to a support base. Oftentimes, parallelism in the tracks is of the utmost importance. For example, a track that deviates even slightly from parallel can negatively affect the performance of an entire linear motion system.

Some other prior art solutions include simply placing a track directly into a T-slot of a base support extrusion. These known solutions oftentimes result in an unacceptably imprecise fit. For example, commercially available base support extrusions will vary in T-slot width for any given mill run. Therefore, a track having a uniform width will either fit too tightly or too loosely within the extrusion's T-slot. Therefore, there is a need to provide a track support extrusion that can reliably accommodate a standard-sized track despite the occasion of small size variances.

SUMMARY OF THE INVENTION

The invention provides novel approaches to manufacturing and assembling linear motion guide tracks that are quick and easy to install. Some embodiments of the invention involve a track clamp that couples with standard linear motion support bases without the use of fasteners.

The elimination of fasteners results in lower cost, faster assembly, and increased structural integrity due to the elimination of drill holes and tapped holes in the track. According to some embodiments of the present invention, traditional fasteners are replaced with track clamp having deformable teeth protrusions.

Some embodiments of the invention utilize track clamps having a pressure insert portion with teeth protrusions that deform upon coupling with the support base. The deformation of the track clamp teeth ensures a tight fit without the use of fasteners.

Various embodiments of the invention include track clamps designed to couple tracks to support bases in a variety of configurations including tracks disposed orthogonally to the support base. In some embodiments of the present invention, track clamps are designed with shoulder extensions to provide extra support to withstand lateral forces bearing on the track.

In some embodiments of the invention, the track clamp is designed to suit any slot in a wide variety of extrusions or barstock material. According to one aspect of the present invention, the track clamp enables the user to integrate a V-shaped edge track into the T-slots of standard structural extrusion support bases.

Some embodiments of the invention teach low cost methods of installing linear motion tracks into structural extrusion support bases. In some embodiments, the novel track clamp is simply installed using a soft-headed mallet. In some other embodiments, the track is able to be installed by using a cross-head arrangement of rollers to uniformly apply force to insert the track clamp and track into standard structural extrusion support bases.

In some embodiments, the track clamp and guide track are assembled in a factory. In some other embodiments, the track clamp and guide track are assembled on-site by an end user.

In some embodiments of the invention, the track clamps are integrated with widely available standard aluminum extrusion support bases. In some embodiments of the present invention, track clamps are especially designed to accommodate various sized V-shaped edge tracks For example, in some embodiments, the track clamp is designed for tracks sized 0 thru 4, in carbon steel or stainless steel. In some embodiments of the invention, the track and track assembly are chosen to be used with DualVee® guide wheels, manufactured by Bishop-Wisecarver Corporation.

In some embodiments of the present invention, methods of manufacturing track clamps having deformable teeth protrusions are disclosed.

Some embodiments of the invention include a bolt-on track clamp for housing a track and coupling with a support base extrusion. These solutions provide customers with a simple-to-assemble, customizable, reconfigurable, and user-friendly solution for reliable track assembly.

Some other embodiments include a back-to-back track configuration that is coupled to a proprietary base extrusion using clamping washers. These solutions are also user-friendly and convenient, and they also save space.

In yet other embodiments, a custom made extrusion includes deformable fingers in a T-slot for handling varying track widths and for resisting unplanned disengagement of the track from the support base.

Some embodiments of the invention involve track clamp for coupling a track with a base extrusion via a support extrusion and a wedge assembly. Some other embodiments of the invention involve a double-edged support extrusion for coupling a track with a guide wheel via a wedge assembly according to some embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an exploded upper perspective view of a guided motion assembly requiring fasteners previously known in the art;

FIG. **2**A is an end view of a track clamp according to the invention;

FIG. **2**B is an isometric view of the track clamp shown in FIG. **2**A;

FIG. **2**C is an exploded upper perspective view of a guided motion assembly according to the invention;

FIG. **3**A is an end view of a support base extrusion coupled with a pair of linear motion tracks via track clamps according to the invention;

FIG. **3**B is a flow chart illustrating process steps for a method of manufacturing a guided motion system according to the invention;

FIG. **4** is an end view of an alternative support base extrusion coupled with a pair of linear motion tracks via track clamps according to the invention;

FIG. **5** is an end view of third support base extrusion coupled with a pair of linear motion tracks via track clamps according to the invention;

FIG. **6** is an end view of an fourth support base extrusion coupled with a linear motion track via a track clamp according to the invention;

FIG. **7**A is an upper isometric view of a bolt-on track clamp and a track according to the invention;

FIG. **7**B is an end view of the bolt-on track clamp shown in FIG. **7**A;

FIG. **7**C is an exploded upper isometric view of a support base extrusion and two bolt-on track clamps of the type shown in FIGS. **7**A and **7**B according to the invention;

FIG. **7**D is an end view of a nut used in a bolt-down track clamp according to the invention;

FIG. **7**E is an end view of an assembled track system with bolt-on track clamps coupled with support base extrusions according to the invention;

FIG. **7**F is an upper isometric view of a guide wheel assembly according to the invention.

FIG. **7**G is an exploded upper isometric view of an assembled track system capable of being coupled with a slidable beam extrusion via a plurality of guide wheel assemblies according to the invention;

FIG. **8**A is an exploded upper isometric view of a back-to-back track assembly according to the invention;

FIG. **8**B is a partially transparent upper isometric view of a retaining washer used in the assembly shown in FIG. **8**A;

FIG. **8**C is an end view of the back-to-back track assembly shown in FIG. **8**A in an assembled configuration;

FIG. **8**D is an exploded view of the track assembly shown in FIGS. **8**A-**8**C, a support base, and a plurality of guide wheel assemblies according to the invention;

FIG. **9**A is a disappearing end perspective view of a support base extrusion having a plurality of deformable fingers disposed in a track slot with a track inserted therein according to the invention;

FIG. **9**B is an upper perspective view of support base extrusion having a plurality of deformable fingers disposed in oppositely disposed track slots, each track slot having a track inserted therein, according to the invention; and

FIG. **10**A an exploded end view of an assembly for coupling a track with a base extrusion via a support extrusion and a wedge assembly according to the invention;

FIG. **10**B is an end view of a wedge assembly according to the invention;

FIG. **11**A is an exploded view of a track system using a support extrusion and wedge assembly to couple tracks to a base extrusion according to the invention;

FIG. **11**B illustrates an end view of the track system shown in FIG. **11**A in an assembled configuration;

FIG. **11**C is an upper isometric view of a track system similar to the embodiment shown in FIGS. **11**A and **11**B with brakes and wheel covers;

FIG. **11**D is a lower isometric view of the track system shown in FIG. **11**C;

FIG. **11**E is a flow chart showing the method steps involved in assembling a track with a base extrusion via a support extrusion and a wedge according to the invention;

FIG. **12**A is a side view of a double-edged support extrusion for coupling a track with a base extrusion via a wedge assembly according to the invention; and

FIG. **12**B is an upper isometric view of a double-edged support extrusion for coupling a track with a guide wheel via a wedge assembly and with brakes and lubricators according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

A track clamp for coupling a linear motion guide track to a support base according to the invention is referred to at **200** in FIGS. **2**A-**2**C. The track clamp **200** comprises two clamp arms **210**, **220** which are connected to a base section **201** to form a well **230**. As shown, the two arms **210**, **220** extend vertically away from the base section **201** and terminate at a fixed distance from the base section **201**, thus defining well **230**.

The well **230** is configured to accommodate a linear motion guide track **297**. Two shoulders **211**, **221** are disposed at the end, and on the outer sides of the arms **210**, **220**. As described, the assembly **200** is configured to be inserted into a support base **295** such that the well is disposed within the support base. Likewise, the support base interacts with the shoulders **211**, **221** such that the assembly rests upon the surface of the support base. Additionally, two sets of teeth protrusions **250** are disposed on the outer surfaces **240** of the arms **210**, **220**. In the illustrated embodiment of the present invention, the teeth protrusions **250** are configured such that they must be deformed to be inserted into a support base, thus coupling with the support base without using fasteners.

The teeth protrusions **250** are deformed and/or sheared by the press-fitting into a support base extrusion **295**. Preferably, the deformation of the teeth protrusions **250** causes the arms **210**, **220** to be displaced toward each other as indicated by the arrows in FIG. **2**A. The displacement clamps a track **297** between the arms **210**, **220**.

According to one aspect of the invention, the deformation of the teeth protrusions **250** effectuates a cold-pressure solid-state welding process.

A suitable guide wheel **298** is a DualVee® guide wheel manufactured by Bishop-Wisecarver Corporation. A suitable guide track **297** is a V-shaped guide track also manufactured by Bishop-Wisecarver Corporation, designed for use with DualVee® guide wheels.

With reference now to FIG. **3**A, a track assembly **300** is shown wherein track clamps **325** are press-fitted into a support base **330**. In one aspect of the invention, each track clamp **325** is configured such that it is easily coupled with the support base **330** using only hand tools. In the illustrated embodiment of the present invention, the track clamp **325** is configured such that a simple rubber mallet can easily force the track clamp into the support base **330**. However, it will be readily apparent to those having ordinary skill in the art that a wide variety of coupling mechanisms can be used.

The simple and secure coupling ability of the invention provides distinct and useful advantages of the approaches known in the art. For example, since linear motion tracks can be easily assembled without expensive and complicated tools, a cost savings is realized. Additionally, the time to install a linear motion track is reduced through the elimination of complicated assembly techniques. By using a track clamp **325** that is compatible with standard extrusions, investment in all new support bases is unnecessary and greater manufacturing consistency is possible. Furthermore, the track clamps **325** of the invention provide a more secure coupling than other coupling techniques that do not use traditional fasteners.

As explained above, teeth protrusions **350** are disposed on the arms **310**, **320** of the track assemblies **320**. As a result of the press-fitted coupling, the teeth protrusions **350** are deformed, thus ensuring a secure fit between the track clamp **325** and the support base **330**. Additionally, the shoulders **311**, **321** provide additional support to the track **320**. For example, torque applied to the track **320** (indicated with arrows **398**, **399**) is resisted by the shoulders **311**, **321**.

It will be readily apparent to those having ordinary skill in the art that the components disclosed in FIG. **3**A, and in other embodiments of the invention may take various sizes, shapes and appearance. In some embodiments, the arms **310**, **320** of the track clamp **325** are spaced between 3 mm and 12 mm apart. In some embodiments, the track **320**, the base **330** and the track clamp **325** are between 3 m and 6 m long.

In some embodiments, the track clamp **325**, as recited, is substantially comprised of steel. In some embodiments, the track clamp **325** as recited is substantially comprised of stainless steel. In some embodiments the track clamp **325** is formed by extrusion. In some embodiments the track clamp **325** is formed by metal injection molding.

Method steps of manufacturing a guided motion system using the novel track clamp of the invention are shown in FIG. **3**B. The method starts by providing a guided motion support base **396**, providing a track **395**, and providing a track clamp **394** as discussed above. The guided motion support base has at least one conduit disposed therein for accepting the track clamp. In some embodiments of the invention, the track clamp has a cross-section that is substantially U-shaped and includes a plurality of teeth protrusions disposed on the outside surface of the assembly.

The method of manufacturing shown in FIG. **3**B continues with coupling the track with the track clamp **397**. Next, the coupled guide track/track clamp is press-fitted into the conduit of the support base **398**. As explained above, a rubber mallet may easily tap the track/track clamp into the support base. According to some embodiments, the teeth protrusions on the track clamp are deformed when the track clamp is press-fitted in the support base, thus providing a secure coupling. Finally, the assembled guided motion assembly is slidably coupled with one or more guide wheels **399**.

In some embodiments of the invention, the method further comprises manufacturing the track, the support base, and/or the track clamp. In other embodiments, the components are formed using an extrusion. In still other embodiments, the components are formed by metal injection molding.

Although FIG. **3**A illustrates a support base **330** with two track assemblies **325** and two guide tracks **320**, it will be readily apparent to those having ordinary skill in the art, that guide track assemblies in a variety of configurations may be formed according to the invention.

FIGS. **4-6** illustrate several alternate embodiments of linear motion tracks using track assemblies according to the invention.

FIG. **4** shows a linear motion apparatus **400** comprising a support base **430** disposed vertically between two guide wheels **440**, **445**. The support base **430** is coupled to tracks **420** via assembly **425**. One or more teeth protrusions such as those discussed above, although not shown, are disposed on the assembly **425**.

FIG. **5** shows another linear motion apparatus **500** comprising a support base **530** disposed between two guide wheels **540**, **545**. The support base **530** is coupled to tracks **520** via assembly **525**. One or more teeth protrusions such as those discussed above, although not shown, are disposed on the assembly **525**.

Referring next to FIG. **6**, a linear motion apparatus **600** comprising a support base **630** is disposed vertically between two guide wheels **640**, **645**. The support base **630** is coupled to tracks **620** via track clamp **625**. A plurality of teeth protrusions **627**, **628** are disposed on the assembly **625**.

The track clamp **625** includes a plug section **626** having a plurality of teeth protrusions **627**, **628** disposed on the outer side of the plug section **626**. Additionally, the plug section **626** includes a cap section **629** coupled to the plug section **626** wherein the cap section **629** is at least partially wider than the plug section, forming shoulders **631**, **632** which rest upon the surface of the support base **630** when the track clamp **625** is coupled with the base section **630**. Furthermore, a well **635** is disposed in the cap section **629** configured to hold the track **620** therein. According to some embodiments of the present invention, and as shown in FIG. **6**, the orientation of the well **635** within the cap section **629** is substantially orthogonal to the orientation of the plug section **626**. In some embodiments of the invention, the cap section **629** and the plug section **626** form an integral whole.

As explained above, there is an existing need in the art for an apparatus and system for providing customers with a simple-to-assemble, customizable, reconfigurable, and user-friendly solution for reliable track assembly. To meet this need, some other embodiments of the invention involve fastening of a track to a support base using standard commercially-available hardware and a novel bolt-on clamp extrusion. The bolt-on clamp extrusion also allows effortless parallel alignment of the track using a raised alignment ridge that accommodates variously-sized bolt-receiving slots in support base extrusions. Other advantages of these embodiments of the invention will be readily apparent to those with ordinary skill in the art.

A bolt-on clamp extrusion **700** and a track **710** according to the invention are shown in FIGS. 7A and 7B. The bolt-on clamp extrusion **700** comprises an elongated, integral axial member **701** having a connected end **702** and two arms **703**, **704** disposed in parallel planes. The two arms **703**, **704** terminate with two clamping fingers **708**, **709** in a finger-clamping region **706** at the end opposite the connected end **702**.

The two horizontally disposed arms **703**, **704** define a gap **705** extending along the length of the bolt-on clamp extrusion **700**. The gap **705** is configured to accept the insertion of a track **710**. The gap **705** extends in the X-direction past the finger-clamping region **706** into a bolt-down region **707**.

The bolt-down region **707** of the arms **703**, **704** includes a plurality of pre-drilled conduits **711**, each of which line up in the Y-direction as they pass through each of the arms **703**, **704**. The pre-drilled conduits **711** are configured for accommodating a bolt **720** such that at least a portion of the bolt extends completely through each conduit **711** for coupling with a nut **715**. The bolt-down region **707** also includes an outwardly-protruding alignment ridge **712** extending axially on the underside length of the bolt-on clamp extrusion **700**. The alignment ridge **712** is configured to self-align with a slot of a support base extrusion **798** such that a track **710** inserted in to the bolt-on clamp extrusion **700** remains parallel to the support base extrusion.

Maintaining parallelism between the track and the support base extrusion is extremely important. However, as explained above, previous solutions require careful measuring, alignment, and drilling. Accordingly, self-alignment between the alignment ridge **712** and a slot of the support base extrusion provides a simple way to position the two work pieces in parallel alignment when assembling a track system.

In some embodiments of the invention, the alignment ridge **712** is narrower than the width of the slot of the support base extrusion, such that the alignment ridge **712** can align with either side of the slot.

This embodiment of the invention combines the multiple advantages of sure formation of parallel guide tracks, a secure coupling and clamping mechanism, and ease of assembly. For example, a user of the bolt-on clamp extrusions **700** does not need a sophisticated machining shop to assemble a linear guide system. As explained above, known solutions oftentimes require that the end user cut, drill, or otherwise machine work pieces to configure a linear guide system. However, bolt-on clamp extrusions require only commercially available parts and are easily assembled and reconfigured.

A support base extrusion **799** and two bolt-on clamp extrusions **700**, according to another embodiment, of the invention is shown in FIGS. 7C and 7E. The support base extrusion **799** comprises an integral member **798** extending axially in the z-direction. The support base extrusion **799** comprises a plurality of T-slots **797** disposed along the length of the support base extrusion **799**.

The pre-drilled conduits **711** of the bolt-on clamp extrusions **700** align with T-slots **797** of the support base extrusion **799** and a plurality of nuts **715** and bolts **720** couple the bolt-on clamp extrusions **700** with the support base extrusion **799**. The plurality of nuts **715** are inserted into the T-slots **797** of the support base extrusion **799**.

A nut **715**, shown in FIG. 7D, includes arms **716** which contact the inner-surface of the T-slot **797** when the nut **715** is tightened.

In the illustrated embodiment, a plurality of bolts **720** is inserted through the pre-drilled conduits **711** and extends into the T-slots **797** where they couple with nuts **715**. In the illustrated embodiments of the invention, tightening the bolts **720** to the nuts secures the bolt-on clamp extrusions **700** to the support base extrusion **799**.

Tightening the nuts **715** and bolts **720** also deforms the arm **703** and the finger **708**, thereby clamping the finger-clamping region **706** onto the track **710** inserted therein.

A guide wheel assembly **789** suitable for use with the track system **730** shown in FIGS. 7C and 7E comprises a DualVee® guide wheel **788** coupled with a T-bar **787**. The T-bar **787** is configured to slidably couple with a T-slot of a standard beam extrusion. The DualVee® guide wheel **788** includes a V-shaped valley **786** for accommodating a track **710** of the track system **730**.

FIG. 7G shows an assembled track system **730** ready for coupling with a slidable beam extrusion **785** using a plurality of guide wheel assemblies **789**. The track bars **787** of the guide wheel assemblies **789** slide into a T-slot of the slidable beam extrusion **785** until the track **710** is engaged with the

V-shaped valley **786** of the DualVee® guide wheel **788**. In some embodiments of the invention, a felt wiper may be coupled to slidable beam extrusion **785**. In yet other embodiments, a brake mechanism can be included in the system.

The bolt-on clamp extrusion track assemblies **730** provide users with a simple-to-assemble, customizable, reconfigurable, and user-friendly solution for reliable track assembly. Moreover, the tracks are readily replaceable to accommodate tracks made of other material and to service a track that may need to be straightened or otherwise serviced. Other advantages will be apparent to those with ordinary skill in the art having the benefit of this disclosure.

FIGS. **8**A through **8**D illustrate additional embodiments of the invention including a back-to-back track assembly **800**.

The back-to-back track assembly **800** shown in FIG. **8**A includes a base extrusion **801** that includes an outwardly-protruding alignment ridge **812** configured to self-align with a slot of a support base extrusion (not shown), as explained above. The base extrusion **801** also includes a plurality of pre-drilled conduits **811**, each of which line up in the Y-direction as they pass through the base extrusion **801**. The pre-drilled conduits **811** are configured for accommodating a plurality of bolts **820** such that at least a portion of the bolts **820** extend completely through the base extrusion **801** for coupling with one of a plurality of nuts **815**. The back-to-back track assembly **800** also includes two tracks **810** that lay on the base extrusion **801** and are coupled to the base extrusion **801** via a plurality of retaining washers **899**. As shown in FIG. **8**C, the retaining washers **899** couple the tracks **810** to the base extrusion **801** by sandwiching the tracks **810** between the retaining washer **899** and the base extrusion **801** and securing the coupling by screwing the bolt **820** into the nut **815**. In the illustrated embodiment of the invention, the retaining washers **899** are countersunk, as shown in FIG. **8**B.

FIG. **8**D is an exploded view of an assembled track system **830** ready for coupling with a slidable beam extrusion **885** using a plurality of guide wheel assemblies **889**. The track bars **887** of the guide wheel assemblies **889** slide into a T-slot of the slidable beam extrusion **885** until the track **810** is engaged with the V-shaped valley **886** of the DualVee® guide wheel **888**. In some embodiments of the invention, a felt lubrication wiper may be coupled to slidable beam extrusion **885**. In yet other embodiments, a brake mechanism can be included in the system.

The back-to-back track assemblies also provide users with a simple-to-assemble, customizable, reconfigurable, and user-friendly solution for reliable track assembly. Moreover, the tracks are readily replaceable to accommodate tracks made of other material and to service a track that may need to be straightened or otherwise serviced. Other advantages will be apparent to those with ordinary skill in the art.

Other embodiments of the invention include a custom-made, snap-in support base extrusion for holding a track without the use of an assembly or without using fasteners. FIGS. **9**A and **9**B illustrate some other embodiments of the invention which include a snap-in support base extrusion **999**.

As explained above, some other prior art solutions include simply placing a track directly into a T-slot of a base support extrusion. These known solutions results in an unacceptably imprecise fit. For example, T-slots in commercially available base support extrusions will vary in width for any given mill run. Therefore, a track having a uniform width will either fit to tightly or too loosely within the slot. A solution to this problem is addressed by creating a plurality of deformable fingers in a track slot that elastically and/or plastically deform when a track is inserted into the slot, thereby resisting the removal of the track and ensuring a tight fit despite variations in track or slot size.

FIG. **9**A shows a support base extrusion with a plurality of deformable fingers disposed in the slot with a track inserted therein according to some embodiments of the invention. FIG. **9**B shows an alternate example of a support base extrusion with a plurality of deformable fingers disposed in the slot with a track inserted therein according to some other embodiments of the invention.

Another solution to imprecisely-fitting tracks involves the introduction of a wedge assembly into a slot on a support extrusion along with the track. FIG. **10**A shows an assembly **1000** for coupling a track **1010** with a base extrusion **1020** via a support extrusion **1030** and a wedge assembly **1040** according to one embodiment of the invention. As seen in FIG. **10**B, the wedge **1040** comprises a protrusion **1041** on a first side of the wedge **1040** and a plurality of deformable teeth **1042** on an opposite side of the wedge **1040**.

In the illustrated embodiments of the invention, the protrusion **1041** and the plurality of deformable teeth **1042** extend along the length of the wedge assembly **1040**. However, in other embodiments, the protrusion **1041** and the plurality of deformable teeth **1042** are placed regularly, intermittently, randomly, or bookended along wedge **1040**.

Referring again to FIG. **10**A, the support extrusion **1030** includes a well **1035** and a slit **1045** extending along the length of the support extrusion **1030**. The slit **1045** is configured for securely accepting the protrusion **1041** of the wedge **1040** when the wedge **1040** is inserted into the well **1035**. Likewise, the track **1010** is configured to be press-fitted into the well **1035** by deforming or shearing the teeth **1042** of the wedge **1040**, thereby securely holding the track **1010** within the support extrusion **1030**. Indeed, a tight coherent fit is formed between the track **1010** and the support extrusion **1030**, thereby minimizing movement of the track during use.

In some applications, a separate wedge **1042** is superior to a work piece having integral teeth because the process of extruding teeth protrusions can be delicate and lead to unacceptable waste.

In one aspect of the invention, the support extrusion **1030** comprises an outwardly-protruding alignment ridge **1050** extending along the length of the underside of the support extrusion **1030**. The alignment ridge **1050** is configured to self-align with a slot **1060** of the base extrusion **1020** such that the assembly **1000** remains aligned when the assembly **1000** is coupled with the base extrusion **1020** (explained below).

Maintaining alignment between the track **1010** and the support extrusion **1020** is extremely important. However, as explained above, previous solutions require careful measuring, alignment, and drilling. Accordingly, self-alignment between the alignment ridge **1050** and the slot **1060** of the support extrusion **1020** provides a simple way to ensure parallel alignment of the two work pieces when assembling a track system. In some embodiments of the invention, the alignment ridge **1050** is narrower than the width of the slot **1060** of the support extrusion **1030**, such that the alignment ridge **1050** can align with either side of the slot.

With reference now to FIGS. **11**A and **11**B, two assemblies **1100** are formed by press-fitting tracks **1110** into support extrusions **1130** having wedges **1140**. According to FIG. **11**A, the support extrusion **1130** includes a series of conduits **1155** for accepting the insertion of a plurality of bolts **1156** therethrough. Likewise, each of the slots **1060** in the base extrusion **1120** is configured such that one or more T-nuts **1170** fit therein. Each slot **1060** is defined by an opening **1062** and a slot core **1064**.

The assembled assemblies **1100** are aligned with a base extrusion **1120** and a plurality of T-nuts **1170** are inserted into one or more slots **1060** such that the T-nuts **1170** are captured in the slot cores **1064** as shown in FIG. **11**B. Additionally, a plurality of guide wheels **1180** are aligned with the tracks **1110**. Likewise, the plurality of guide wheels **1180** are configured to be coupled with a moveable extrusion **1190**.

According to FIG. **11**B, the bolts **1156** are inserted through the conduits and coupled with the T-nuts **1170**, thereby securing the support extrusion **1130** with the base extrusion **1120**. Likewise, the guide wheels **1180** are aligned with the tracks **1110** and, hence, with moveable extrusion **1190**.

In some embodiments the track system described in FIGS. **11**A and **11**B include one or more of brakes, lubricators, and wheel covers. In some embodiments, the wheel covers **1194** include their own lubrication system with two lubricated felts per wheel cover.

Referring next to FIG. **11**E, the method for assembling an assembly a track with a base extrusion via a support extrusion and a wedge according to some embodiments of the invention begins with providing a base extrusion having at least one slot disposed with an opening is narrower than the slot core at step S**111**. The method continues with inserting a plurality of nuts into the slot at step S**112** and providing a support extrusion having a well disposed therein including a slit disposed therein at step S**113**.

The method continues with drilling the support extrusion with a plurality of conduits at step S**114**, inserting a plurality of bolts through said plurality of conduits at step S**115**, screwing said bolts into said nuts at step S**116**.

The method continues with inserting a wedge with a protrusion and deformable teeth into the well at step S**117**, press-fitting a track into the partially-filled well, thereby deforming the deformable teeth and securely holding the track within the well at step S**118**.

Next, the method involves providing a moveable extrusion at step S**119** and providing at least one guide wheel configured to rotationally couple with the track extrusion such that the moveable extrusion moves with respect to the track at step S**120**.

Some embodiments of the invention involve a double-edged support extrusion for coupling a track with a base extrusion via a wedge according to some embodiments of the invention. For example, FIG. **12**A shows a double-edged support extrusion **1200** for coupling a track **1210** with a guide wheel **1220** via a wedge **1240**. FIG. **12**B shows a double-edged support extrusion **1200** for coupling a track **1210** with a guide wheel **1220** via a wedge **1240** having brakes **1201** and lubricators **1202**.

In the illustrated embodiments of the invention, the track system comprises a coefficient of friction ranging from 0.005 to 0.02. Likewise, the track systems can be fully customized to the end-user's environment using carbon or stainless steel track, and carbon, or stainless steel wheels, or low temp, high temp, corrosion-resistant, or custom grease wheel versions.

The invention has been described in terms of specific embodiments incorporating details to facilitate the understanding of the principles of construction and operation of the invention. Such reference herein to specific embodiments and details thereof is not intended to limit the scope of the claims appended hereto. It will be apparent to those skilled in the art that modifications can be made in the embodiment chosen for illustration without departing from the spirit and scope of the invention. Specifically, it will be apparent to one of ordinary skill in the art that the device and method of the invention could be implemented in several different ways and have several different appearances.

The invention claimed is:

1. A system for securing a linear motion guide track to a support extrusion comprising:

the linear motion guide track having a track interface surface;

a wedge having a first side, a second side opposite said first side, a protrusion on said first side, and a plurality of deformable teeth disposed on said second side;

the support extrusion having at least one well including a slit configured to accept the protrusion of said wedge, insertion of said protrusion in said slit positioning said wedge in and partially filling said at least one well,

wherein when said linear motion guide track is press-fitted into said partially-filled at least one well, said plurality of deformable teeth are deformed such that said linear motion guide track is securely held within said at least one well with at least a portion of said track interface surface protruding from said at least one well.

2. The system according to claim **1**, wherein said support extrusion further comprises a plurality of conduits extending therethrough in a direction perpendicular to said support extrusion.

3. The system according to claim **2**, further comprising a substantially planar base extrusion having at least one slot including an opening and a slot core, wherein said opening is narrower than said slot core.

4. The system according to claim **3**, further comprising:

a plurality of nuts inserted into said at least one slot and captured in said slot core; and

a plurality of bolts inserted through said plurality of conduits,

said plurality of nuts configured such that said nuts resist the application of an outward force on said plurality of nuts through their contact with said slot core of said opening,

wherein screwing said plurality of bolts into said plurality of nuts creates an upward force on said nuts such that said resistance secures said support extrusion with said base extrusion.

5. The system according to claim **4**, wherein said support extrusion further comprises an alignment ridge configured to align with at least one side of said opening, thereby ensuring that said support extrusion is disposed in parallel alignment with said base extrusion.

6. The system according to claim **3**, further comprising:

a moveable extrusion, and

at least one guide wheel configured to rotationally couple with said track interface surface of said linear motion guide track, and further configured for coupling with said moveable extrusion such that said moveable extrusion moves with respect to said linear motion guide track.

7. The system according to claim **6**, further comprising at least one brake coupled to said moveable extrusion configured to apply pressure to said linear motion guide track, thereby at least partially resisting said movement.

8. The system according to claim **6**, further comprising at least one lubricator coupled to said moveable extrusion configured to lubricate said linear motion guide track.

9. The system according to claim **6**, further comprising at least one wheel cover coupled to the at least one guide wheel.

10. The system according to claim **6**, further comprising:

at least one additional linear motion guide track having an additional track interface surface;

at least one additional wedge having a first side, and a second side opposite said first side, an additional protrusion on said first side thereof; and at least one additional plurality of deformable teeth disposed on said second side;

at least one additional well disposed on an opposite side of said support extrusion from said at least one well including an additional slit configured to accept the at least one additional protrusion of said at least one additional wedge, insertion of said additional protrusion in said at least additional slit positioning said at least one additional wedge in and partially filling said at least one additional well,

wherein when said at least one additional linear motion guide track is press-fitted into said partially-filled at least one additional well said at least one additional plurality of deformable teeth are deformed such that said at least one additional linear motion guide track is securely held within said at least one additional well with at least a portion of said at least one additional track interface surface protruding from said at least one additional well.

11. A method of securing a linear motion guide track to a support extrusion comprising:

providing a support extrusion having at least one well including a slit;

inserting a wedge into said at least one well, thereby partially filling said at least one well, said wedge having a first side, a second side opposite said first side, a protrusion on said first side; and a plurality of deformable teeth disposed on said second side, the slit of said at least one well configured to accept the protrusion of said wedge,

press-fitting a linear motion guide track into said at least one partially-filled well, said linear motion guide track having a track interface surface, thereby deforming said plurality of deformable teeth such that said linear motion guide track is securely held within said at least one well, and wherein at least a portion of said track interface surface protrudes from said at least one well upon said press-fitting.

12. The method according to claim **11**, further comprising drilling said support extrusion with a plurality of conduits extending therethrough in a direction perpendicular to said support extrusion.

13. The method according to claim **12**, further comprising:

providing a substantially planar base extrusion at least one slot having an opening and a slot core, wherein said opening is narrower than said slot core.

14. The method according to claim **13**, further comprising:

inserting a plurality of nuts into said at least one slot, wherein said plurality of nuts are configured such that said plurality nuts resist the application of an outward force on said nuts through their contact with the core-side of said opening, and

inserting a plurality of bolts through said plurality of conduits,

screwing said plurality of bolts into said plurality of nuts, thereby creating an upward force on said nuts such that said resistance secures said support extrusion with said base extrusion.

15. The method according to claim **14**, further comprising providing an alignment ridge on said support extrusion, said alignment ridge extending along the length of said support extrusion, wherein said alignment ridge is configured to align with at least one side of said opening, thereby ensuring that said support extrusion is in parallel alignment with said base extrusion.

16. The method according to claim **13**, further comprising:

providing a moveable extrusion; and

providing at least one guide wheel configured to rotationally couple with said track interface surface of said linear motion guide track, and further configured for coupling with said moveable extrusion such that said moveable extrusion sides moves with respect to said linear motion guide track.

17. The method according to claim **16**, further comprising coupling at least one brake to said moveable extrusion, wherein said at least one brake is configured to apply pressure to said linear motion guide track, thereby at least partially resisting said sliding.

18. The method according to claim **16**, further comprising coupling at least one lubricator to said moveable extrusion, wherein said lubricator is configured to lubricate said linear motion guide track.

19. The method according to claim **16** further comprising coupling at least one wheel cover to said guide wheel.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 8,608,383 B2
APPLICATION NO. : 12/939804
DATED : December 17, 2013
INVENTOR(S) : Nigel S. Watson

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Drawings
On Sheet 21, Fig 11E, in the second line of the first text box “is” should be deleted between “opening” and “narrower.”.

In the Specification
In Column 1, Line 58, “in a standard” should read –in standard–.
In Column 3, Line 43, “tracks For example” should read –tracks. For example–.
In Column 3, Line 45, “thru” should read –through–.
In Column 3, Line 65, --a-- should be inserted between “involve” and “track.”.
In Column 4, Line 26, “of third” should read –of a third–.
In Column 4, Line 29, “an fourth” should read –a fourth–.
In Column 4, Line 64, “of support” should read –of a support–.
In Column 5, Line 1, --is-- should be inserted between “Fig. 10A” and “an exploded.”.
In Column 6, Line 8, “advantages of” should read –advantages over–.
In Column 8, Line 32, “embodiment. of” should read –embodiment of–.
In Column 8, Line 33, “is shown” should read –are shown–.
In Column 9, Line 61, “results in” should read –result in–.
In Column 9, Line 65, “to tightly” should read –too tightly–.
In Column 11, Line 14, “include” should read –includes–.
In Column 11, Line 19, “assembling an assembly a track” should read –assembling a track–.

In the Claims
In Column 14, Line 8, “plurality nuts resist” should read –plurality of nuts resists–.
In Column 14, Line 30, “sides” should be deleted between “extrusion” and “moves.”.

Signed and Sealed this
Sixth Day of June, 2017

Michelle K. Lee
Director of the United States Patent and Trademark Office